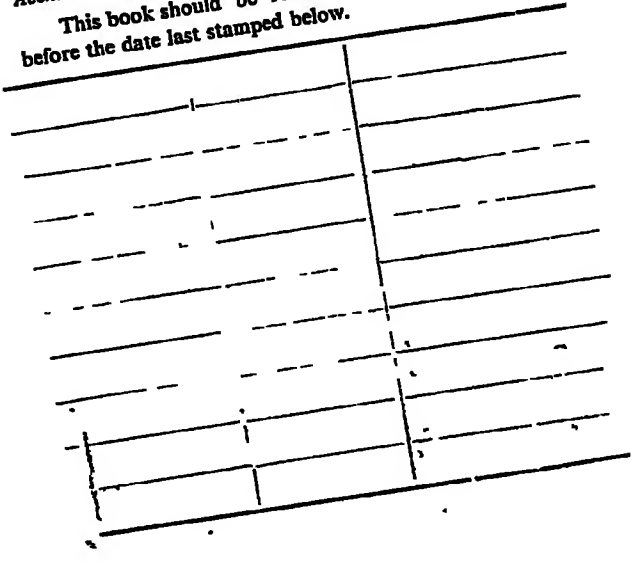

FOREST RESEARCH IN INDIA,

1934-35

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CONTENTS.

FOREST RESEARCH IN INDIA, 1934-35.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

Work was continued in accordance with the sanctioned programme and all urgent problems submitted to the Research Institute were attended to. The Board of Forestry which met in October 1934 considered the necessary co-operation in research between the Provinces and the Forest Research Institute and the advancement of forestry in India.

Silvicultural Branch.—The most important event of the year was the 4th Silvicultural Conference held during the year. This was attended by 35 delegates representing all the Provinces and most of the important Indian States. Important decisions were taken regarding research methods and a large field of silvicultural work was covered.

The investigations on various silvicultural problems were continued in accordance with the triennial programme and satisfactory advance was recorded in several directions.

The severe frost of January 1935 killed many plants down to the ground and vitiated important experiments in the Demonstration Area. The teak experimental plantations have been almost entirely destroyed.

The all-Indian teak seed origin investigation has been taken a step further and is likely to provide valuable data for areas where all seed has to be imported.

Statistical work shows a steady increase and the staff was fully occupied in computing data of sample plot files received from the provinces. The number of permanent sample plots has increased from 1246 in 1930-31 to 1502 in 1934-35.

The year under review records completion of a note on "Forest Types" now in the press.

The photographic section records important additions of prints, lantern slides and cinema films. Slides and films were lent to a few

Divisional Forest Officers and the Forest Research Institute arranged for a public lecture on the utility of forests in Kotdwara illustrated with lantern slides.

The Ceylon Government obtained the services of Mr. H. G. Champion, the Central Silviculturist, for about four months to advise them regarding forest policy.

Botanical Branch.—The systematic study of several important tree species in particular *Dipterocarpaceae* and *Terminalias* was continued. There was a further addition of 3,560 sheets to the herbarium and 1,258 specimens were distributed to various museums in foreign countries on an exchange basis. The card indexing of periodicals and books on botanical subjects was brought up to date. The Botanist spent a good deal of his time in identifying specimens and answering technical enquiries on botanical subjects from forest officers all over India. The determination of the Hydrogen ion value of forest soils with reference to problems of regeneration in the Kulu division of the Punjab received attention. The President has to thank Dr. McKenzie Taylor of the Irrigation Research Institute, Lahore, for his very valuable services in this investigation. His work is being published as a forest record.

In mycology the investigation of the shisham root disease has been closed and a report is being written up. The Mycologist continued his investigations of rust disease on conifers in Chakrata and a large collection of possible alternate hosts was made.

Entomology.—The entomological branch has maintained a high output in the fields of pure entomology, forest protection and the utilisation of timber. Some of the results have appeared in the twenty-three articles published during the year.

The relative importance of insects, fungi and other factors in the dying-off of *Shorea robusta* was investigated with the conclusion that only one insect, *Hoplocerambyx spinicornis*, is capable of killing healthy trees. Measures for the protection of standing sal trees from damage by secondary borers were successfully applied.

Biological work on the borer pests of living trees, such as the *Phassus* borer of teak, eucalyptus and cryptomeria, the *Estigmena* and *Cyrtotrachelus* borers of bamboo, show that effective control can be obtained by modification or correct application of silvicultural measures.

Dr. Beeson's demonstration that the principles of biological control can be applied to teak plantations for protection against defoliators introduces what is probably the solution to all the problems of pest suppression in "pure" plantations. Most of the remedies can be attained by silvicultural operations if these are supplemented by the introduction of parasites and predators.

Borers of logs, of plywood and planking and of timber in salt water, have been investigated and measures have been devised for reduction of the damage caused by them. Mr. Gardner's taxonomic studies of the larval stages of borers have removed many of the difficulties connected with their identification.

Special attention has been paid to a pest of champ plantations, *Urostylis punctigera*, the seasonal history of which has been worked out, and to the economic importance of cutworms and cockchafers in coniferous forests.

About 25,000 insects were bred in the Dehra Dun insectary and 570 new species were added to the Institute collection.

Economic Branch.—The Institute has lost the services of Mr. L. N. Seaman who had initiated all the work done on the testing of Indian Timbers and whose association with the Institute over a long period of years has been very valuable. Before leaving Mr. Seaman was able to complete his proposals for the grading of teak squares. A work which involved the assessment and valuation of defects in 6,000 teak squares, the property of the leading Burma firms. This matter is now under the consideration of the firms concerned and it is hoped that a standard classification throughout the trade will soon be an accomplished fact.

A further meeting of the Raman Committee to consider the treating of timber with "Ascu" was held at Simla in June 1934 and a good deal of correspondence has taken place regarding treated telegraph poles. A large experimental treatment of railway sleepers will be undertaken.

The President convened a meeting of all the pulp and paper interests of India in Calcutta in March 1935 to consider what research should be carried out at Dehra Dun. It is a pleasure to record that this conference was most successful.

Dr. Kapur's experiments on seasoning have considerably reduced the cost of this process in which many people are now becoming interested. One of the most important investigations in hand is the suitability of Indian woods for veneer and considerable progress was made. A certain amount of interest was also shown in the commercial application of our work.

The services of the wood technologist continued to be in much request with the public and various Government departments and the day to day enquiries have increased considerably so much so that it is difficult to find time for the items of research down in the triennial programme.

Not much headway can be made with the limited staff available in the minor products section. Some progress is recorded in the

collection of information of important forest drugs and the cultivation of some of these was continued.

Chemistry Branch.—During the year under report investigations on *Derris*, which yields the valuable insecticide rotenone, have been continued. Of the several species examined *D. elliptica* from Assam has been found to contain over 2 per cent. of rotenone and may be classed amongst the good quality commercial *Derris*. This is important since it opens up the possibility of its cultivation on commercial lines. Investigation on other plants, reputed to act as fish poison, have also yielded interesting results.

The study of the *Laurinacea* fats has been continued with a view to find possible indigenous sources of lauric acid. This investigation assumes a certain amount of importance in view of the fact that sodium lauryl sulphate is being extensively employed as a base for new detergents.

A study of the fluorescence of wood under ultra violet light was made and the results in some cases are so striking that it is believed that systematic study of this phenomena correlating the nature of fluorescence with the constitution of timber and its anatomical structure may prove of value as an aid to identification. A coloured plate was published in the April number of the *Indian Forester*, 1935.

Mr. C. G. Trevor was President of the Institute during the year; he wishes to thank all members of the staff for their loyal co-operation in the advancement of forest research in spite of the somewhat limited funds available for the purpose.

CHAPTER II.—SILVICULTURE BRANCH.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

The following publications dealing with Experimental results obtained at the New Forest were published during 1934-35.

1. Cold weather planting in North India (Forest Bulletin No. 86).
2. Seasonal Progress of Height Growth in Trees (Forest Bulletin No. 88).
3. The effect of defoliation on the increment of teak saplings (Forest Bulletin No. 89).
4. A note on the use of paper tubes in planting (*Indian Forester*, January 1935).

Several of the investigations, however, are completed or sufficiently advanced to permit of useful deductions being drawn and they are being written up. Forest Bulletin No. 41 (" A note on the Weights of Seeds ") has been revised and is almost ready for publication.

(ii) Natural Regeneration.

The study of annual seed production and fertility of individual trees of *Anogeissus latifolia* (Expt. No. 44) was continued for the 7th year. Although seeding had been profuse, a severe hail-storm destroyed the seed crop almost completely before it was ready for collection.

The seed crop from individual trees of *Shorea robusta*, *Pinus longifolia* and *Terminalia tomentosa* (Experiment No. 10) were again recorded. 1931 was a good seed year for the last two species, but sal did not produce any seed. These records will have to be continued for several years more before conclusions can be arrived at with any precision.

(iii) Investigation on seeds.

(*a*) *Seed weighments and germination tests.*—During the year, 121 weighments were made including 26 new species and germination tests of 77 species were recorded.

(*b*) *Effect of size of seed on germination and growth of seedlings.*—The Experiment (No. 57) was carried out with *Terminalia tomentosa* in 1934. Seeds were graded into 4 diameter classes before sowings and the experiment showed that the bigger the seed the better the result, both in respect of germination as well as in height growth.

(c) *Seed storage.*—Two species were added to the list under investigation, *viz.*, *Acacia catechu* and *Acer caesium.*

Seeds of *Acacia catechu* and *Bombax malabaricum* stored in gunny bags failed to germinate after 2 years; the seeds were found to have become rotten; seeds stored in sealed tins shewed 2 per cent. and 37 per cent. germination respectively. *Cinnamomum camphora*, after having been stored in gunny bags and in sealed tins for 2 years, failed to germinate in both cases. *Schleichera trijuga* and *Melia azedarach* gave 19 per cent. and 71 per cent. germination respectively after 2 years' storage in sealed tins, and 2 per cent. and 20 per cent. respectively after the same period in gunny bags.

In general, if seeds are to be kept they should in most cases be packed in sealed tins and not in bags.

(iv) Investigation on seedlings.

The morphological seedling studies as reproduced in *Troup's Silviculture of Indian Trees* were completed for 10 species, namely:—

Alstonia scholaris, Canarium bengalensis, Canarium strictum, Eugenia grandis, Swietenia macrophylla, Terminalia citrina, Terminalia paniculata, Bursera serrata, Tecoma undulata and *Boehmeria regulosa.*

(v) Investigation on trees and crops.

(a) *Seasonal course of height growth.*—The compilation work on 15 common Indian species has been published (*vide* Forest Bulletin No. 88). The investigation is being continued.

(b) *Phenological data.*—Observations were continued on 15 species. Preliminary compilation work has been done, but detailed analysis remains pending.

(c) *Inheritance of individual characters.*—Plants from seeds of known figured and unfigured *Terminalia tomentosa* trees of south India were raised in pots and planted out during the cold weather. Plants of *Pinus longifolia* raised from seed from trees with varying resin yielding capacity were planted with a view to determining whether the resin yielding capacity is a hereditary character.

(d) *Inheritance of climatic race characters.*—The All-India teak seed experiment, dealing with eleven origins, is being kept under observation for detailed study as regards phenology.

Ordinary C grade thinnings were carried out in *Acacia catechu* in both local and Burma origins. Burma origin is decidedly better than the local origin both in height as well as in diameter growth, and the noticeable difference in the colour of the foliage between the two origins

is maintained, the Burma plants being light yellowish green and the local plants dark green. The heartwood from both the origins is being examined by the Bio-chemist for cutch content.

(e) *Inheritance of physiological race characters.*—Small plantations of *Butea* and *Schleichera* forms reported to behave differently under lac culture were being kept under observation. Most of the plants have been badly affected by the last frost.

(f) *Soil quality class indicators.*—The quadrats in plantations of different important species in the Demonstration Area were continued, and mapping has been done up to date. The results await analysis.

(g) *Congestion in bamboo clumps.*—This experiment (No. 8) was laid out in the Experimental garden in July 1934, to study causes of congestion in bamboo. Fellings have been carried out according to prescribed treatments during the year under review and it is too early to give any conclusions yet

(h) *Root competition.*—The investigation in sal and chir to study the effect of root competition of the suppressed and dominated stems on the dominant trees is still in progress.

(i) *Thinnings in young plantations.*—The two sets of plots laid out in the 1925 chir plantation and reported in last year are still under observation.

(j) *Pruning* versus *natural cleaning.*—50 comparable pairs of trees in the 1926 chir plantation area were selected, one set was pruned while the other was left to nature as a control.

(k) *Twist in Pinus longifolia.*—In the 1926 plantation of Kangra and Hazara origins, 20 plants of each origin were subjected in 1931, to each of the following treatments :—(1) Partial barking, (2) Topping, (3) Binding and (4) Control, to determine whether such mal-treatment causes any increase in the occurrence of twist.

A thinning of plants raised in 1928 by sowing seeds collected from selected twisted trees, was done in February 1935, and the saplings removed are being examined.

Pot plants raised in 1934 from X-ray treated seeds, with and without water treatment in 16 different ways, were planted out during the following cold weather in the Demonstration Area, with a view to ascertain whether X-ray treatment causes any twist in the plants so raised.

(vi) Artificial Regeneration.

Weather conditions affecting results were as follows :—

The 1933 rains were exceptionally good and well distributed The following cold weather had a normal rainfall and a severe frost. The

1934 monsoon broke out on the 17th June and rains were regular up to September.

The 1934-35 cold weather was marked by a fairly good rainfall but a very severe frost occurred on the 15th, 16th and 17th January 1935 resulting in heavy casualties in plants, especially in teak, *Shorea robusta, Dalbergia latifolia* and *Terminalia tomentosa.*

(*a*) *Line sowings.*—Various species were tried both in shade and in the open in 1934, but only a few species, *viz.—Erythrina suberosa, Bauhinia variegata* and *Mallotus philippinensis* gave comparatively good results.

(*b*) *Rains entire transplanting in the open.*—The following species were tried in 1934, the survival percentage at the end of the year being given in brackets :—

Cedrela toona (75), *Lagerstroemia flos-reginae* (99), *Mallotus philippinensis* (63), *Pterospermum acerifolium* (97), *Terminalia arjuna* (79) and *Schima wallichii* (*nil*).

As regards plants put out in 1933, the following results indicate the survivol percentage at the end of 1st and 2nd growing seasons respectively :—*Garuga pinnata* (90—35), *Lannea grandis* (98—92), *Pterocarpus marsupium* (87—63), *Machilus gamblii* (83—*nil*), *Soymida febrifuga* (95—*nil*) and *Cassia siamea* (61—*nil*). *M. gamblii* died due to hot weather of 1934, and *S. febrifuga* and *C. siamea* were killed back owing to severe frost during February 1934.

Since the last enumeration, the severe frost in January 1935 has killed all the plants down to the ground level except *Machilus gamblii* which had already died earlier in the hot weather of 1934 and *Soymida febrifuga* and *Cassia siamea* which had died in the 1934 frost or in the subsequent hot weather.

(*c*) *Rains entire transplanting in cleared lines.*—The following species were put out in 1934, the survival percentage at the end of the year being given in brackets :—

Cedrela toona (69), *Lagerstroemia flos-reginae* (100), *Mallotus philippinensis* (83), *Pterospermum acerifolium* (91) and *Schima wallichii* (15).

For the species tried in 1933, the following figures shew the fall in survival percentage during the 2nd growing season :—

Schleichera trijuga (76 to 44), *Cassia siamea* (40 to *nil*) and *Machilus gamblii* (98 to 70). *Cassia siamea* was all killed out by the frost of February 1934.

(*d*) *Winter entire transplanting in the open and cleared lines.*—It was mentioned in last year's report that out of the six species put out in December 1932 only three survived up to December 1933. Further

observation a year after (December 1934) showed that the survival percentage of *Chloroxylon swietenia* dropped from 5 to 0, of *Lannea grandis* from 47 to 41 and of *Soymida febrifuga* from 26 to 19. The species reported to have been added in January 1934 (*Pterospermum* and *Terminalia* spp.) did not survive on account of frost.

The following species were planted out in January 1935, *viz.*— *Eugenia jambolana, E. operculata, Litsaea polyantha, Terminalia chebula* and *Terminalia paniculata.*

All these species, except *T. chebula*, were also tried in cleared lines.

(*e*) *Winter stump planting in the open and cleared lines.*—The only three species reported last year to have survived of the 1932 December experiments showed the following percentage of survivals at the close of 1933 and 1934 (figures in brackets) :—*Erythrina suberosa* (84 to 55), *Bauhinia retusa* (74 to 64), *B. variegata* (64 to 64).

In January 1934, the following species were put out and survival percentage in November 1934 is given in brackets against each species :—

Ougenia dalbergioides (24), *Stereospermum suaveolens* (89), *Celtis tetranda* (51), *Cedrela toona* (38) and *Eugenia operculata* (*nil*). The last species was not a success on account of frost.

The following seven species were added during January 1935 :— *Pterospermum acerifolium, Chickrassia tabularis, Acacia modesta, Litsaea polyantha, Prosopis juliflora, Trewia nudiflora* and *Acacia catechu.* Of the four species tried in cleared lines in January 1934, only *Ougenia dalbergioides* survived (21 per cent.).

Species planted out in January 1935 in the open, were also tried in cleared lines with the addition of *Chloroxylon swietenia.*

(*f*) *Rains stump planting in the open.*—The following results were obtained at the end of the second growing season with species tried in 1933, the figures in brackets giving survival percentage at the end of the 1st and 2nd seasons respectively :—

Grewia elastica (97—94), *Olea glandulifera* (57—*nil**), *Terminalia chebula* (97—78), *Xylia xylocarpa* (66—*nil**), *Eugenia operculata* (100—100), *Ougenia dalbergioides* (76—62), *Shorea talura* (91—*nil**), *Erythrina suberosa* (93—45), *Acacia arabica* (76—*nil**) and *Garuga pinnata* (98—55).

The species put out during the rains of 1934 are mentioned below, giving their survival percentage at the end of the year in brackets :—

Olea glandulifera (60), *Cassia siamea* (86), *Stereospermum suaveolens* (Stumps 99, root sections 97), *Chloroxylon swietenia* (83), *Mallotus*

*Where the survival percentage at the end of the 2nd year has been shown as *nil* with an asterisk the wholesale casualty was due to the severe frost of February 1934

philippinensis (88 in one case and 76 in another), *Terminalia chebula* (85) and *Prosopis juliflora* (79).

The last observation during February-March 1935 showed that most of these species have been wholly or partially frosted during the last cold weather. How far these will revive will be watched with interest.

(*g*) *Rains stump planting in cleared lines.*—*Phoebe hainesiana* and *Mallotus philippinensis* were put out in July 1934, survival percentage in December 1934 being 70 and 89 respectively. As regards height growth, there is a progressive diminution for each date later than the 12th May. The indications are, therefore, that stumps should be planted at the earliest date at which a reasonably high percentage of success can be obtained, namely three weeks before the break of the rains in this experiment. By so doing an increase of over 80 per cent. in height growth is obtained in the first season with correspondingly greater chances of establishment and reduced casualties in the second and subsequent seasons.

(*h*) *Storage of stumps before planting.*—Experiments were carried out on the lines of the previous year. 250 teak stumps of different diameters, prepared on 3rd July 1934, were planted out in comparable lots of 50 stumps after an exposure up to 20 days to sun, rain and wind, on a cement floor in wire shelter. There was more or less rain on 14 of the 20 days. At the end of the growing season the survival percentage was 94, 90, 78, 56 and 18; and corresponding average height 7·1″, 6·7″, 6·3″, 5·1″ and 4·0″, for stumps exposed for 0, 4, 8, 13 and 20 days respectively, further confirming last year's (as well as earlier) conclusions as to the exceptional vitality of teak stumps.

For 250 teak stumps stored and similarly planted out in 1933 (*vide* last year's report) the survival percentage at the end of the second growing season was 98, 100, 98, 86 and 70, with corresponding average heights of 40·6″, 42·7″, 38·6″, 37·7″ and 32·8″ respectively.

(*i*) *Early planting of stumps without irrigation.*—Teak stumps have been planted fortnightly since the 15th January 1935, both in the open as well as in cleared lines. It is too early to note results yet.

For teak stumps planted fortnightly from the 27th January 1934 to 27th September 1934, the survival percentage after one growing season was 48, 44, 44, 64, 52, 56, 64, 76, 88, 100, 92, 92, 84, 80, 72, 16 and 0 with corresponding average heights 12·8″, 13·9″, 18·2″, 16·6″, 15·5″, 14·5″, 14·9″, 17·7″, 13·9″, 11·6″, 9·7″, 7·9″, 5·0″, 3·7″, 3·0″, 2·0″ and 0″.

It would appear from the above results that stumps planted between the 27th May and the break of rains (21st June) give much higher percentage of survival than those planted out earlier, *e.g.*, February-March.

(*j*) *Comparison of nursery stock and natural seedlings*: *Eugenia jambolana.*—For plants raised from the nursery and planted out in 1932, the survival percentage at the end of each growing season varied from

90 to 75 to 68 up to the third season; for those of natural seedlings planted out the same time the percentage varied from 90 to 52 to 45, there being no significant difference in height.

(*k*) *Comparison of nursery and forest stumps.*—*Eugenia jambolana* was tried in 1933. At the end of the 1st growing season survival was cent. per cent. for both, but at the end of the second growing season the percentage fell to 80 and 90 respectively; the average height of the nursery grown stumps was worked out to be 13·6", while that of the forest stumps was 17·9".

(*l*) *Comparison of sowings, transplants and stumps.*—The following is the record of observations at the end of the third growing season for the four species tested in 1932:—

Gmelina arborea was concluded in August 1934 on account of its having been attacked by some unknown disease still under investigation.

Tectona grandis was planted out as entire transplants and stumps in standard pits and only as stumps in crowbar holes. As regards *Acacia catechu*, *Bauhinia variegata* and *Bombax malabaricum* raised by direct sowing, entire transplanting and stump planting, all in pits, the following tabular statement summarises their results at the end of 1st, 2nd and 3rd growing seasons.

Species.	Method (sowing or transplanting.)	Survival percentage.			Average height in inches at the end of the 3rd year.
		1st year.	2nd year.	3rd year.	
Tectona grandis .	Entires in pits .	70	37	37	52·9
	Stump planting in standard pits.	98	98	98	83·1
	Stump planting in crowbar holes.	93	92	92	79·4
Acacia catechu .	Direct sowing .	93	83	80	60 8
	Entire transplanting	83	80	80	61·6
	Stump planting .	68	43	43	82·6
Bauhinia variegata .	Direct sowing .	100	100	98	90 5
	Entire transplanting	95	87	87	66 6
	Stump planting .	100	98	98	85·1
Bombax malabaricum	Direct sowing .	95	60	60	11·3
	Entire transplanting	95	58	58	10·0
	Stump planting .	95	88	88	24·3

Two more species, viz., *Eugenia jambolana* and *Stereospermum suaveolens* were added in July 1931. Their survival percentage after one growing season are compared as follows:—

Eugenia jambolana 93 for direct sowing, 60 for entire transplanting and 78 for stump planting.

Stereospermum suaveolens 53, 93 and 60 for entire transplanting in crowbar holes, stump planting in standard pits and entire transplanting in standard pits respectively.

(v) *Introduced species.*—The small plantation of *A. camaldulensis* raised in June 1928 is in good condition having already attained a maximum height of 7'-0".

Another small plantation of *A. holosericea* was started in July 1929 but most of the plants were damaged by white ants during 1930-31. Those that survived are growing quite well, having attained a height of 9'-6".

(vii) Nursery work.

The seed crop on trees especially in the Dun Valley was fairly good during the year. Stock of various species was raised for use in the Experimental Garden. Experiments with different types of nursery bed shades (providing different degrees of shade) to study their effect on germination and growth were carried out in the nursery with the following species

Albizzia procera.—The conclusions drawn are as follows:—

(*a*) In the unshaded bed, germination commenced last of all with the result that plants were very small.

Germination in shaded beds commenced fairly early, and was completed at the same time

(*b*) Germination was best under a tin shade, seedlings were so dense as to damp off in patches where they were very thick.

(*c*) The bed under a batten shade was thinly stocked all over due to excessive rain getting in; it was better stocked than the one under thatch.

(*d*) The bed with a thatch shade started fairly well but later on the seedlings were almost entirely destroyed by drip.

(viii) Miscellaneous.

(*a*) *Effect of defoliation on diameter increment of teak.*—The results of this experiment have been published in Forest Bulletin No. 89. It was found that three defoliations in a season resulted in a 60 to 70 per cent. loss of normal increment in height, basal area and volume. A

fourth defoliation resulted in a 50 per cent. mortality and a loss of 65 to 75 per cent. of the normal increment. Further losses of approximately 50 per cent. occurred in the second year in trees defoliated three times in two years in succession.

(*b*) *Method of working bamboos for maximum sustained yield in quantity and value.*—All the provincial plots, initiated by the Experimental Assistant in co-operation with the Provincial Research Officers, are being maintained by the latter on approved lines. Notes on observations or cultural operations from time to time are being passed on to the Forest Research Institute for record and necessary compilation. Only the plots within the Hoshiarpur division in the Punjab were remeasured by a field Assistant of the Central Silviculturist during the year.

(*c*) *The all-India teak seed origin investigation.*—A summary of the results obtained so far from the all-India teak seed origin experiments organised by the Forest Research Institute has been compiled and was circulated at the time of the 4th Silvicultural Conference held in October 1934 (*vide* pages 119-122 of the printed proceedings of the said conference).

(ix) Reclamation and afforestation.

The year under review proved fatal to teak, *Dalbergia latifolia* and *Terminalia tomentosa* in the experimental area on account of frost. Even local species like sal, *Bombax malabaricum* and *Albizzia procera* suffered severely.

Four compartments in which *Gmelina arborea* had been killed out by disease were given out for taungya cultivation during 1933. The compartments were sown in lines 10′ apart with *Acacia catechu* during the rains of 1934.

(*a*) *Sal working circle.*—Two compartments of about 1·5 acres were sown with Gorakhpur large and small seeded sal. The plants are in a healthy condition and were not affected by the frost as they had been given adequate protection by shades during the winter.

Blanks occurring in compartments containing sal plants of local, Haldwani, and Hoshiarpur seed origins were filled up by direct sowing during the last rains.

(*b*) *Pinus longifolia working circle.*—Casualties were replaced with Hazara, Nainital and Lansdowne origins during the rains.

A light C-grade thinning was carried out over the whole area of the 1925 and 1926 plantations, and a systematic pruning of selected stems was done in 6 of these compartments during the cold weather of 1934-35.

(*c*) *Rosewood working circle.*—The attack of *Ascomycete fungi* on rosewood and the very severe frost of January 1935 have again damaged

the plants very considerably. Constant failures with this species during the past few years have led to the conclusion that no further attempts at growing it here are justified. Natural sissoo will be allowed to take its place.

II.—STATISTICAL WORK.

(i) Yield tables.

Stand tables giving the distribution of trees by diameters in crops of different ages were prepared for *Shorea robusta* coppice to supplement the existing yield table.

The records of a number of comparative thinnings sample plots in Bihar and Orissa and Madras were analysed for initial comparability. The statistical problems connected with the Madras set have been put before Professor P. C. Mahalanobis of the Presidency College, Calcutta, for his opinions regarding the most satisfactory methods of analysing them.

Von Wulfing's yield tables for teak plantations in Java were converted from metric units to feet and inches, they were adapted to the standards and mode of presentation of the Indian teak plantation yield tables and were published as Forest Bulletin No. 87.

The routine work of computing the data in the standard sample plot files received from the provinces occupied as usual most of the time of the computing staff. 275 files were received during the year for computation, and 514 plot files were actually computed, thereby considerably reducing arrears.

The total number of sample plots maintained is steadily increasing as the following statement shows.

Year.	No. of permanent sample plots maintained.
1930-31	1,246
1931-32	1,327
1932-33	1,475
1933-34	1,475
1934-35	1,502

Of these plots 364 are in the United Provinces and 326 in Burma, the remainder being in other parts of British India. In addition to the above 332 temporary sample plots have been measured up to date.

(ii) Volume tables.

A local volume table for *Pterocarpus santalinus* giving heartwood outturn was compiled for the Chamala Valley, Chittoor Division, Madras.

Single tree data from the Punjab for standard volume measurements and commercial volume measurements were computed for 678 trees of 5 different species.

Tables for solid (πr^2) volumes of logs of lengths up to 30 feet and mid-diameters up to 36" were prepared, and a table of bark percentages corresponding to different diameters over and under bark was compiled.

(iii) Miscellaneous.

In connection with the Silvicultural Conference held in October/November 1934 suggestions for amendments to the Statistical Code were collected from all provinces, critically examined, and then discussed at the conference. The resulting decisions will be published as corrections to the Code. In this connection the results of an investigation into the precision of the standard Indian sample plot methods were published in the Indian Forester (October 1934).

A considerable amount of statistical analysis of data from the experimental section was done during the year including the computation of the figures relating to the effect of defoliation on the increment of teak.

Miscellaneous.

(i) Photographic section.

The routine work dealt with compares with previous years as follows:—

Year.	Negatives made.	Prints made.	Lantern slides made.	Colour photos.
1932-33	677	2,276	44	..
1933-34	1,095	2,271	400	..
1934-35	932	3,420	130	18

Of the new negatives, 150 were photographs taken by the Silviculturist on tours in Bengal and Ceylon, 2 by the Experimental Assistant in the Central Provinces, and 25 by the Mycologist at Chakrata. 245 photographs concern the Timber Testing Section and a further 221 were photographs taken for other branches and sections of the Institute. 283 negatives were sent by the Silviculturists of Madras, Kashmir, United Provinces and by the Forest Research Officer, Bihar and Orissa, to be lodged in the Forest Research Institute collection. Many of these photographs were of great interest and the increased co-operation of the Provincial Silviculturists and other forest officers in sending such photographs is much appreciated,

Out of the 3,420 prints made, the silvicultural collection has been increased by 390 making the total 4,203 in the specific series and by 393 to 3,372 in the general series. 866 prints were prepared for different provinces and native states. 351 prints were received directly or indirectly from provinces. 37 prints were exhibited at the 4th Silvicultural Conference, and an exhibit was given demonstrating correct and incorrect technique in forest photography. 88 photographs were used as illustrations in various publications.

An attempt was made to demonstrate the possibilities of colour photography by different screen plate processes at the Silvicultural Conference, but the results were not very satisfactory probably owing to inexperience and faulty manipulation.

130 lantern slides were prepared and added to the collection which has now become fairly comprehensive. 56 slides were sent for by the Silviculturist, U. P., and the Principal, Madras Forest College and a number of slides were lent to the Divisional Forest Officer, Chittagong Division, to show at an industrial exhibition and for local propaganda purposes. The Range Officer of the Demonstration Area of the Institute was sent to Kotdwara where he delivered a public lantern lecture on the Utility of Forests illustrated by slides from the Forest Research Institute collection.

A number of stereoscopic photographs were added to the collection during the year. It is felt that greater use might well be made of stereoscopic methods which are particularly suitable for forestry subjects.

A successful cinema exhibition was given during the Silvicultural Conference, using the Forest Research Institute sub-standard projector and a second projector kindly lent by Mr. Shebbeare. The films shown were mostly taken by forest officers of forest subjects, and included a purely silvicultural film on "Making a teak Plantation" by Mr. M. F. Bridge, Divisional Forest Officer, South Coimbatore, Madras. Efforts are being made to start a collection of sub-standard films of forestry subjects and offers of a few films have been received. It is hoped that all forest officers who own cinema cameras will co-operate in making this collection as comprehensive and interesting as possible.

(ii) Records.

Owing to lack of an assistant able to read German and French the referencing of foreign literature fell seriously into arrears during the year. The Silviculturist unaided cannot possibly find time to read or translate more than a fraction of the articles in foreign languages that call for scrutiny with the result that many have had to be referenced by titles only without even a summary in English.

Some progress was made in the marking for ledgering of Working Plans by the Statistical Assistant to whom this work was given. 109 plans were marked, but the cutting up and filing of these has become a big task and will take some time. All publications on Indian Forestry were abstracted as usual for "Biological Abstracts."

The number of new specific ledger files opened during the year was 23 bringing the total up to 1,203, the corresponding figures for the general ledger files being 7 and 438. The compilation of a note on the forest types of India is nearing completion and will be published shortly. The question of compiling a general manual of Indian Silviculture which would be largely based on the general ledger files is under consideration.

26 new books were added to the silvicultural library during the year including 17 working plans, bringing the total up to 633 volumes and 464 bound periodicals. The usual list of important additions was circulated with brief abstracts to Provincial Silviculturists.

(iii) Working Plans.

Notes were written on the Sadiya draft working plan and the suggestions made have been generally adopted in the plan.

(iv) Museum.

The model of a sample plot in Deodar forest referred to last year has been completed to a scale of 1/40th of actual size. The model of the irrigated plantation of *Dalbergia sissoo* representing the plantations in the Punjab deserts was reconstructed and improved, and the construction of a working model to demonstrate the influence of forest cover in preventing erosion has been commenced. A few of the photographs in the museum were hand-coloured by the Artist.

(v) Staff and touring.

During April to June 1934 the Silviculturist made a tour in North Bengal in Darjeeling, Kurseong and Kalimpong Divisions where he visited the hill taungyas.

The post of the Silviculturist was held in abeyance from the 14th November 1934 to the 20th February 1935 during which period his services were lent to the Ceylon Government to advise them regarding their future forest policy. The post of Experimental Assistant also fell vacant from 18th November 1934 when Mr. P. N. Deogun reverted to his province, and was not filled until 1st April 1935 when Mr. J. N. Sen Gupta succeeded him.

The Statistical Assistant laid out an experiment with 'Atlas' tree killer solutions at Asarori in Dehra Dun division, and also took full

measurements of the *Dalbergia sissoo* sample plot No. 1 at Chila in Lansdowne Division, United Provinces, which was to be clearfelled, the object being to see how far the volume arrived at by our sample tree method agrees with the actual volume of the plot.

Ranger Bachaspati Nautiyal of the Demonstration Area was transferred to the United Provinces and was succeeded by another United Provinces Ranger Hari Krishan Madhwal. No other changes in staff have taken place.

(vi) Silvicultural Conference.

The chief event of the year was the 4th Silvicultural Conference held in the Forest Research Institute from 29th October to 3rd November 1934. Thirty-five delegates attended from all provinces of India and Burma and from the native states of Chamba, Hyderabad (Deccan), Kashmir, Mysore and Travancore. The agenda included 26 items, several of them sub-divided, and almost the whole field of silvicultural work was covered. Important decisions were reached regarding research methods and many other matters.

CHAPTER III.—BOTANY BRANCH.

1. *Systematic Botany.*—The systematic study of important timber trees of the family *Dipterocarpacea* was continued during the year. The final proof of a paper in the Indian Forest Records on *Dipterocarpus macrocarpus* Vesque, the two Burmese trees *Scaphula glabra* Parker and *Anisoptera oblonga* Dyer, and the two South Indian *Hopeas*, *H. glabra* W. & A. and *H. wightiana* Wall. has been corrected. Further work on the trees of this family was done and the following five species will now be dealt with, three allied species of *Shorea*, *S. assamica* Dyer, *S. floribunda* Kurz and *S. sericeiflora* Fisch. & Hutch., two little-known Burmese *Hopeas*, *H. oblongifolia* Dyer and *H. helferi* Brandis. The two South Indian species of *Dipterocarpus*, *D. indicus* Bedd. and *D. bourdilloni* Brandis are also under investigation to complete the study of the Indian species of that genus.

Further examination of the material of the Indian *Terminalias* of the section *Pentaptera* was continued. None of the first lot of herbarium specimens sent to Berlin for comparison agreed satisfactorily with Roth's type of *Terminalia alata* and *T. crenulata* and a further lot of 23 herbarium sheets has been sent and the report on them is awaited. The genus has been found to be a difficult one as some overlapping of specific characters is evident and hybrids occur.

A note on the systematy of some Indian and Burmese *Dillenias* hitherto confused in herbaria and on one of the little-known Burmese bamboo. *Melocanna humilis* Kurz have been completed and submitted for publication in the Indian Forester.

A paper on some new and little-known plants from Kumaon, in which two new species, *Viscum osmastonii* and *Phlogacanthus lambertii*, were described and figured and a third species, *Sinomenium acutum* Rehder and Wilson, was figured and recorded for India, was published in the Indian Forester and also a paper on the Vegetation of the hill-tops of Tenasserim.

2. *Herbarium.*—During the year 3,560 herbarium sheets were incorporated. Of these nearly 1,200 were from the Malayan collections previously donated by the Superintendent of the Royal Botanic Garden, Calcutta, about 750 were from collections made by the Forest Botanist and his staff and 646 were received from the Director of the New York Botanic Garden. The latter include many duplicates of the collections made by Dr. W. N. Koelz in the Sutlej valley in 1930 in connection with the Himalayan Research Institute of the Roerich Museum and are a welcome and valuable addition to our herbarium. The remainder was made up chiefly of collections received on an exchange basis or by dona-

tion from the Director of the Natural History Museum, Stockholm, the Herbarium of the Temple University, Philadelphia, the National Herbarium, Victoria, Melbourne, the Imperial Forestry Institute Herbarium (Southern Nigeria collections), from Mr. H. C. Gill, I.C.S. (Spiti collections), Mr. R. N. Parker, I.F.S. (Punjab collections) the Forest Botanist, Burma (duplicates from collections made by Brigadier C. C. Foss at Maymyo), Mr. J. C. Nath, I.F.S. (Sunderbans collections) and numerous smaller collections from forest officers and others from various parts of India sent in for identification.

The following were distributed either as donations or on an exchange basis :—

Botanic Garden and Museum, Berlin	239
Maymyo Herbarium	190
Royal Botanic Gardens, Edinburgh	320
New York Botanic Garden	145
Temple University, Philadelphia	34
Harvard University, Jamaica Plain, Mass., United States of America (Arnold Arboretum)	75
Gray Herbarium, Harvard University, Mass., United States of America	104
Naturhistoriska Riksmuseet, Botaniska Avdelningen, Sweden	81
School of Forestry, Victoria, Australia	18
TOTAL .	1,256

117 herbarium sheets, chiefly *Avicennia*, *Meconopsis* and *Phabe* were sent out on loan for study and 119 were sent to various herbaria for confirmation of identifications or critical comparison with types.

The re-arrangement of the foreign (non-Indian) collections in the herbarium was continued and the work has now progressed as far as the Compositae (Bentham & Hooker arrangement) representing about half the herbarium. This work is done by the Herbarium Clerk in addition to his usual routine herbarium work.

3. *Library.*—During the year 48 volumes of periodicals and 45 volumes of books were added to the library. The work of card indexing references to literature on select botanical subjects contained in the volumes of our library was undertaken and has nearly been completed. This work entailed the examination of most of the periodicals and other books in the herbarium library and was done chiefly out of office hours by Messrs. A. Hafiz Khan, Mukat Behari Raizada and the Forest Botanist. The want of such an index has been keenly felt recently and the benefit of the work that has been done is already appreciable. It will be completed as early as possible.

4. *Identification of specimens.*—1,365 specimens were identified during the year. These include the identifications of 169 specimens collected by the Forest Botanist when on tour in Bengal and communicated to the Conservator of Forests, Bengal in connection with the determinations of trees along linear sample plots. The remainder are chiefly the collections sent in by the Forest Botanist, Burma, Messrs. V. S. Rao and J. C. Nath, I.F.S., Bengal, Dr. N. L. Bor, I.F.S., Assam, Mr. H. G. Champion, I.F.S. (specimens from the Darjeeling Himalaya), the Silviculturist, Forest Research Division, Punjab and the Divisional Forest Officer, Chittagong Hill Tracts. Numerous smaller collections were sent in by Research and Divisional Forest Officers from various parts of India. These identifications are done in the nature of routine work and take a large part of the time of the Forest Botanist and his assistant.

Tours.—The Forest Botanist toured in the Parbatti valley of the Kulu division during the months of May and June 1934. A large number of soil samples were taken for the determination of their Ph. value in connection with the problem of the regeneration of Spruce and Silver fir with a view to ascertaining the bearing of this factor on their regeneration; a large collection of botanical specimens was also made at altitudes ranging from about 6,000 to 14,000 feet representative of the flora of the locality in flower at that time of the year. A second tour was made in the Chittagong Collectorate and Hill Tracts with the Conservator of Forests and Silviculturist, Bengal, in connection with the identification of trees on the linear sample plots and other trees of forest importance. A large collection of herbarium specimens was also made for the Dehra Dun herbarium and exchange purposes.

5. *Supply of seed.*—The demand for small authentic samples of seed continues and many indents of this nature from various scientific departments and institutions, chiefly on an exchange basis, were complied with. Twenty three large indents aggregating some 3,600 pounds of seed were also complied with during the year. The seed mostly in demand was that of *Pinus longifolia* of which a large quantity was shipped to the Director of Forestry, Union of South Africa. The other kinds supplied were *Pinus khasya* to South Africa, *Cupressus torulosa* to Ceylon, *Tectona grandis* (Malabar, Godavari and Central Provinces types), *Dalbergia latifolia*, *Pterocarpus marsupium* and *Acacia arabica* to Java, *Ougeinia dalbergioides* to Portuguese India, *Terminalia chebula* to Cutch State and *Leucæna glauca* to Bengal.

6. *Arboretum, Fruticetum and Botanic Garden.*—Planting in the arboretum continues to make good progress about 250 plants having been put out during the year. Among these were 15 species of *Eucalyptus* which were planted out in groups of which *E. torelliana*, *E. tereticornis* and *E. naudiniana* have already made excellent growth. In

the planting up of avenues good progress has been made in the replacement of exotics which are not doing well at New Forest with local ornamental trees and such exotics as have been tried and are known to do well under our conditions. The north and south avenue, north of the east wing of the main building which was planted up with *Mimusops hexandra*, *Afzelia quanzensis* and *Melaleuca styphelioides* has been replanted with *Pongamia pinnata* the first mentioned species do not show promise of doing well; the *Cleroxylon* avenue has been interplanted with *Eucalyptus robusta* in the hope that the shade afforded by the *Eucalyptus*, which are doing well, will be beneficial to the *Cleroxylon* most of which have not done well.

Work in the new botanic garden has been taken well in hand and during the short period of eight months, since its inception, about 150 plants representing about 150 genera and 60 families have been planted out. These plants have been raised in our nursery or obtained by transfer from the old fruticetum which will be gradually abandoned. The site of the new botanic garden is an excellent one and very suitable for the formation of a garden for economic, aesthetic and educational purposes.

This winter unusually severe frost accompanied the cold wave that was experienced in Northern India and damaged many plants in the arboretum and botanic garden. Little or no damage was however done to such plants as *Taraktogenos kurzii*, *Xylia xylocarpa*, *Acrocarpus fraxinifolius*, *Aesculus purdueana*, *Acacia saligna* (the green-barked Acacia of the Transvaal), *Enterolobium timbouva* and others.

In addition to some 700 plants raised for planting out in the arboretum and botanic garden about 500 more were also raised and distributed for planting in the residential grounds at New Forest and in the adjoining Indian Military Academy and elsewhere.

The following plants were recorded as having flowered for the first time at New Forest :—*Alangium cordata* R. Br., *Eucalyptus umbellata* Thunb., *Peltophorum africanum* Sond. *Bauhinia corymbosa* Roxb., *Chilopsis saligna* D. Don., *Catalpa kaempferi* S. & Z., *Dalbergia lepcara* Hance, *Ligustrum nepalense* Wall., *L. compactum* Hk. f. & Th., *Stereospermum glandulosum* Miq., *Pennisetum purpureum* Schum, *Cephalotaxus drupacea* S. & Z., *Citrus nobilis* Lour, *Nephelium tomentosum* F. v. M., *Joannesia princeps* Vell, *Rhus viminalis* Vahl., *Gleditschia sinensis* Lamk., *Lithraea molleioides* Engel., *Tristania conferta* R. Br. and *Greyia sutherlandi* Hk. & Harv.

7. *Miscellaneous.*—Many enquiries of a technical nature were answered and advice was given on botanical matters to forest officers and others in various parts of India.

8. *Staff.*—The post of Forest Botanist was held throughout the year by Mr. C. E. Parkinson who was assisted by Mr. Muknt Behari Raizada, Lower Grade Assistant.

The mycological work reported on below was carried out by Dr. K. D. Bagchee, Mycologist, Mr. A. Hafiz Khan, Upper Grade Assistant, and Mr. R. N. Chatterjee, Laboratory Assistant.

Mycology.

9. *Shisham root disease.*—Observations were made on the shisham trees inoculated with Fusarium sp. Cultural studies of *Fusarium* sp. *Ganoderma lucidum* and *Polyporus gilvus* were continued. A report on the investigation of the shisham root disease is being prepared.

10. *The die-back disease of Gmelina arborea.*—This problem has been transferred to the Forest Entomologist with a view to finding out the part played by various insects *viz.*, Tingid bugs, Alcides gmelinae and Calopepla leayana, in the mortality of *G. arborea* in the demonstration area at the Forest Research Institute. Cultural work on the *Coniothecium* sp. and its Phomastage (pycnial sori) isolated from the *Gmelina* shoots was continued.

11. *Peridermium himalayense and Cronartium himalayense.*—This rust was found on *Pinus longifolia* in the Dharmigadh and Dhanrash blocks, Bawar range, Chakrata division in May and June and the *Cronartium* stage on *Swertia alata* in the same blocks in September and October. The observations made in the Almora division have thus been verified.

Peridermium indicum on Pinus excelsa and Cronartium sp. on Ribes rubrum.—

Ribes plants were successfully inoculated in three different localities in the Chakrata division during May and June with *Peridermium indicum* received from Kulu division. Uredo inoculations were also done and this stage repeated and the teleutostage reproduced. A large number of cross inoculations were done on *Pinus excelsa* with the Cronartium sp. (teleutostage) from Ribes in the same forest during September and October, with the object of reproducing the aecidialstage on Pine. The results are awaited.

Peridermium cedri, P. brevius, P. Thomsoni, P. piceae and Peridermium sp. on Abies pindrow.—A collection of a large number of rusts on various broad-leaved species was made in the Chakrata division, during two seasons, May-June and September-October, in order to select the probable alternate host of these fungi. This collection is now under examination. A detailed study of the mode of parasitism of these coniferous needle rusts and the morphology of the rusts on various broad-leaved hosts, some of which are likely to be the alternate hosts, is also in progress.

12. *Damping-off disease of seedlings of forest importance.*—Damping-off records and the germination data in natural garden soil, garden soil and sand mixtures and garden soil, sand and manure mixture, have been maintained for three successive years for *Soymida febrifuga*, *Terminalia tomentosa*, *Dalbergia latifolia*, *Dalbergia sissoo* and *Gmelina arborea*. The cultural study of the organisms responsible for damping-off has been continued.

13. *Cultural study of wood-rotting fungi and their pathogenecity.*—The wood-decomposing properties of (*a*) *Ganoderma lucidum* (*b*) *Polyporus gilvus* (*c*) *Fomes annosus* (*d*) *Polystictus versicolor* (*e*) *Polystictus sanguineus* and (*f*) *Schizophyllum commune* on blocks of wood have been recorded for 4 and 8 months.

Inoculations were done with *Fomes annosus* and *Armillaria* sp. on *Pinus excelsa* and *Cedrus deodara* in the Chakrata division during two seasons in May-June and after the rains in September-October. The results are awaited. Besides the above the following cultures of wood-rotting and dry-rot fungal organisms for cultural study and inoculation experiments were also maintained :—(*a*) *Polystictus tabacinus* (*b*) *Fomes rimosus* (*c*) *Trametes pini* (*d*) *Fomes tricolor* (*e*) Dry-rot fungus on *Dipterocarpus* sp. (*f*) Dry-rot fungus in *Amoora wallichii* (*g*) Dry-rot fungus in *Cedrus deodara*.

14. *Sal root disease including Polyporus shoreae.*—A large number of specimens of rots and various *Polyporaceae* from the sal forests of Assam and Bihar and Orissa were examined. Attempts are being made to raise cultures of these organisms in order to study their pathogenecity on sal. A recent out-break of sal mortality in Bihar has engaged our attention and it is proposed to do field work in connection with the study of the parasitic fungal flora of that region.

15. *Routine work.—Herbarium.*—The rust flora of the Kagan division and the *Polyporaceae* of the Kumaon and Chakrata forests have been identified and incorporated, while the rusts of Kumaon and Chakrata are being studied. A collection of root-rotting specimens and dry-rots have also been made for the museum.

The examination of treated sleepers of Deodar from the North Western Railway for fungal rot received detailed attention. Deodar rots from Kashmir, dry rot on Deodar from the Punjab and a large number of sal rots were also examined in detail.

The champ (*Michelia champaca*) disease from Kurseong was investigated and a large number of inoculations were done with *Fusarium* sp. isolated from the dead twigs of the plant to corelate the die-back in the forests with fungus attack.

A serious outbreak of canker disease of *Dalbergia latifolia* saplings in the demonstration area at the Forest Research Institute was noticed;

the organism was isolated and healthy trees were inoculated with the cultures. The results are awaited.

The Ph. value of a large number of soil samples form Kulu division were determined.

A large number of cultures of *Ascomycetes* and *Imperfect fungi* are maintained with a view to study their pathogenic behaviour.

CHAPTER IV.—FOREST ENTOMOLOGY.

Insects of Sal.

Measures for the protection of the timber of dying sal in Haldwani division, United Provinces were successful in reducing the incidence of secondary borers to a degree at which no economic damage occurred. The causes of dying-off were investigated and the relative importance of fungi and insects defined; the general question was discussed in an article in the *Indian Forester* on the role of insects in the dying-off of sal.

An outbreak of *Hoplocerambyx spinicornis* occurred in Kalagarh division, United Provinces affecting about 500 trees. This is the first occasion for a long time that an attack by this borer has been of sufficient extent to require a deviation from the working plan, and was probably caused by the excessively high rainfall of June-August in 1933 and 1934.

Control measures against *H. spinicornis* were in force in sal forests in Kurseong division, Bengal during 1934-35, necessitated by increase following cyclone damage. Trap trees yielded about 300 beetles per tree at a cost of about 5 annas a hundred.

Insects of Teak.

Phassus malabaricus.—Additions were made to the list of food-plants of this teak borer. Attack by it on seedlings and saplings of plantation teak is in the nature of an invasion from the main breeding-grounds in miscellaneous shrubs and underwood, and is preventable by destruction of these alternate food-plants in conjunction with weeding operations. Attempts to establish the insect in the Insectary at Dehra Dun were unsuccessful.

Defoliators.—A definite conclusion of research on the defoliation of teak is that control must be achieved and maintained by means of biological methods. Direct action (spraying, trapping, direct destruction, etc.) can never be regarded as a practical measure until plantations can be reliably patrolled for the detection of incipient outbreaks and spraying operations can be carried out with exceptional celerity. The principles of the biological control of defoliators in pure teak stands have been explained in an article in the *Indian Forester*. Briefly the main points are (i) subdivision of large blocks of pure teak by means of pre-existing forest rather than of newly created stands of other species or of mixtures; (ii) establishment of a varied flora under the teak canopy at the outset by retention of coppice re-growth and miscellane-

ous seedlings rather than by the artificial introduction of selected species at a later stage; (iii) elimination of harmful plants including in this category the alternate food-plants of defoliators; (iv) maintenance of an understorey in older stands with regard to its value as a shelter for beneficial animals and as an obstacle to defoliators; (v) introduction of parasites and predators after careful assessment of the factors of the locality. When all the agencies of biological control are working effectively defoliation will be restricted to a light grade of skeletonisation and widespread epidemics will not occur.

The establishment of a suitable plant community inimical to defoliators is the forest officer's task; the assessment and stabilisation of control by natural enemies is main object of entomological research. In this connection a tour was undertaken in teak growing divisions in Bihar and Orissa and the Central Provinces and a survey made of the distribution and incidence of parasites and predators of the chief teak defoliators. A collector also visited Ceylon. Special attention has been paid to the discovery of alternate hosts of parasites of teak pests. Information is now extensive enough to justify the choice of species of parasites of *Hyblaea puera* and *Hapalia machaeralis* for introduction to localities where they are absent.

Numerous new records were made of the lepidoptera feeding on plants associated with teak and additional food-plants of teak defoliators were discovered.

Insects of Sandal.

A few identifications of sandal insects were communicated during the year but several reports are still outstanding.

Insects of Bamboos.

The life-cycle of *Estigmena chinensis* (Chrysomelidae) in *Dendrocalamus strictus* was studied at Dehra Dun.

Beetles which become active at the onset of the monsoon die off by the middle of August. The maximum number of eggs laid by a female is twelve, deposited in batches of two to four on the surface of the internode under the free part of a culm sheath and covered with chewed up fragments of leaf so that they may be mistaken for pellets of excrement. Pupation begins at the end of August in the larval cavity. By the beginning of October about 80 per cent. of the pupae have transformed to beetles. The beetles remain in the cavities until the dry hot weather of April or May when the majority seek cooler shelter in the soil and soil covering. They quickly abandon bamboos felled during the cold weather and spring. The mortality in the beetle

stage is very high. The number of cavities is 4 to 7 times that of the beetles. Control appears to be attainable by maintenance of open uncongested clumps with a minimum of shade.

Cyrtotrachelus dux.—The life-cycle was studied in Lansdowne division, U. P., and at Dehra Dun. Beetles feed at the beginning of the rains on the new culms boring a pit with the long rostrum which is thrust in right up to its base. Feeding may be prolonged at one spot for several hours or even days, and, combined with the subsequent attack o scavengers, results in the death of the upper part of the culm. Eggs are deposited in similar pits located anywhere on internodes and hatch in a week to ten days. The larva bores inwards and works up the culm towards the top grooving the inner walls and perforating the nodes. On reaching the more solid top portion the larva hollows it out, eating the bud tissues and rapidly increasing in size. The length of the tunnel from the point of oviposition to the growing point depends on the rate of growth of the culm. The larval period is about a month and in August the dead top containing the mature larva falls to the ground. The larva buries itself about six inches deep in the soil, pupates and becomes a beetle in October, in which stage it hibernates and aestivates till the following monsoon season. The population of *C. dux* is not numerous but the potential damage due to each individual is high.

In cases of severe outbreaks collection and destruction of dead tops is the only direct remedy. Well thinned open clumps with a minimum of ground shade provide the most effective preventive measure.

The damage done by monkeys, pig, porcupines, and deer is as great as that due to insects.

Insects of Champ.

The insectary maintained at Samsing, Kalimpong, Bengal, was closed down in December 1934 after one year's work. The seasonal history of the champ bug, *Urostylis punctigera* (Pentatomidae) has been worked out. There are five generations in a year of which only the first and last are distinct. From the middle of March to November all stages of various broods are encountered. Hibernation occurs in the adult stage in a state of low activity. Adults may live throughout the colder season for six months in all but considerable mortality occurs in the hibernating population.

It has been demonstrated that the amount of injury caused by the feeding of *Urostylis* on young shoots of champ is dependent on the numbers of bugs present and the age of the plant. One year old plants may be killed by 30 to 40 nymphs in a fortnight; three year old plants are killed by ten times as many bugs in three weeks, and four to five year old trees succumb to the attack of 1,000 to 1,500 bugs in a month.

The extent to which a tree loses its foliage and dies back is thus very variable but fatal attack is less universal than was originally feared. Trees dying back in June to August put out new lateral shoots by September of the same year and those rendered leafless in September or October remain leafless throughout the cold and hot seasons and flush again in August. Trees in 10 to 16 year old plantations which were apparently killed have lost 5 to 15 feet of the stem, *i.e.*, to about 3 inches diameter, but have produced new leaders.

Gregarious flowering of champ is now known to occur in May; flowering trees are not centres for assembly.

Urostylis punctigera is controlled by heavy rainfall, a fungus disease, a chalcid egg parasite, and a coccinellid predator on the eggs and nymphs, and these factors coupled with falling temperatures reduce the population of the bug to base-level by the spring. It is not appreciably abundant during the period October-March.

Attacked champ trees sometimes develop a rot which is associated with a *Fusarium* and other fungi which are under investigation by the Mycologist.

Insects of Deodar.

From investigations made in Chakrata, United Provinces, it has been found that cutworms in deodar sowings belong to at least three species of Agrotinae but so far the cosmopolitan *Argotis ypsilon*, usually considered as the culprit, has not been reared. Their normal food in deodar forests is grass and weeds and the damage done to germinating deodar seedlings appears to be forced and not preferential. Cutworm damage can be prevented by keeping the nursery and beds which are to be sown, free from weeds from August onwards. If weeding is delayed until just before sowing a population of cutworms is left on the ground which will attack seedlings as soon as they germinate.

Cockchafers were investigated in Kulu, Punjab, and 47 species of cetonine, melolonthine and ruteline larvae were discovered in the soil of forests between 3,000, and 9,000 feet; of these 17 species actually occurred in seedbeds. The largest species of cockchafer grub is *Granida albosparsa*; other characteristic species are *Melolontha furcicauda* and *Mimela pectoralis*. Damage actually due to grubs in seedbeds begins in April and is most severe during May.

Nearly all the damage to the older seedlings in direct sowings and to transplants, which is usually ascribed to cockchafers, is actually due to other causes. Investigation shows that soil insects are of much less importance than other factors in causing the death of conifers between the ages of six and thirty months, and that the liability to damage is

not high enough or general enough to warrant special insect control measures. The remedy for mortality among transplants lies in improvement or proper application of cultural methods. Experiments are in progress on protective measures for nurseries.

Notes on cutworms and cockchafers are being published in the *Indian Forester*.

Insects of Gamari.

In connection with the fungus and/or virus diseases of *Gmelina arborea* the life history of a tingid infesting the foliage was studied. The nymphs of the first generation appear at the end of May and are adult by early July. A second generation extends from July to mid-August. The third generation develops from August to the end of September. It is believed that the adults of this generation lay eggs on the bark of twigs and in this stage the winter and hot weather is passed.

The nymphs and adults feed at the base of the blade of the leaf or in the axils, congregating mainly on the lower surface. The leaf becomes mottled and brownish patches form at the base over an area of 1½ to 2 inches. The leaves wither and fall and the shoots eventually die back. Further investigations are in progress.

Insects of Hollock, Mulberry, Oak, Shisham, etc.

The composition of the borer association of felled *hollock* was investigated in Sadiya division, Assam. Shothole and pinhole borers were comparatively scarce and the longicorn and weevil components of the association were diverse and varying in incidence. The evidence confirmed previous deductions that there was no single species (or a few species) breeding in predominant abundance in felled trees, that could be considered capable of killing standing healthy *hollock*.

The mulberry defoliator, *Glyphodes pyolalis* (Pyralidae) was bred throughout the year at Dehra Dun. It passes through six generations annually with hibernation as a larva.

Defoliation of *Quercus dilatata* in the western United Provinces by *Malacosoma indica* (Lasiocampidae) was reported but no field-work was undertaken during the year.

The seasonal history of the leaf-rolling weevil of shisham, *Apoderus sissu* (Curculionidae), was studied in the Insectary. There are eight generations in the course of the year with hibernation as a larva in the fallen leaf-roll in which pupation also occurs. The life-cycle from the time of deposition of the egg to maturation of the beetle is very brief, but the adults are long lived and feed and roll leaves for a considerable period.

Observations were made on the seasonal history of *Chrysocaspeda olcaria* (Geometridae) a defoliator of *Eugenia jambolana*, which is found to have seven generations between mid August and early June of the following year and is presumed to have at least two more generations. Hibernation occurs as a larva.

A collector was sent to Ceylon in conjunction with the visit of the Silviculturist and considerable material in the form of borers, defoliators and soil insects was obtained which provides records of use in interpreting the ecology of forest insects in India.

Borers of Indian Timbers.

Material for the study of timber borers was collected on all tours and at the field-insectary in Kalimpong, Bengal. Other timbers felled at intervals during the cold weather are under study in Kurseong and Jalpaiguri divisions, Bengal. Several enquiries were received about the pests of logs intended for veneers, of made-up plywood, and of softwood planking, etc. A note was published in the *Indian Forester* on the biology and control of boxwood borers of the group *Heterobostrychus, Schistocerus* (Bostrychidae) showing that in mills and factories general disposal of infested waste and an annual clean up can provide effective protection.

The investigation of the seasonal incidence of marine borers in the estuary of the Beypore River, South Malabar, Madras was completed. The dominant species responsible for damage to logs stored in salt or brackish water is *Martesia fluminalis*. Teredo is of minor importance. A report was provided indicating the periods during which logs can be safely handled in water and the measures to be taken if water storage for the whole year is required.

Parasites and Predators.

Parasites of teak defoliators.—The list of parasites of *puera* and *machaeralis* has been materially increased and many of the new species have been described. The former has 25 species of parasites and the latter 45 species of which 4 are common to both. Newly recorded parasites are :—*Cedria anomala* (Braconidae) ; *Anomaloctenus melleus, Cremastus hapaliae, Cremastus* sp., *Mesostenus* sp., *Pristomerus microdon, Trophocampa indubia* (Ichneumonidae) ; *Eutachina civiloides* (Tachinidae), and new hyperparasites are :—*Hemiteles* sp., *Mesochorus indica, Microtoridea secunda* (Ichneumonidae). The life-histories of several species of Braconidae, Ichneumonidae and Tachinidae have been studied at Dehra Dun. An account of the biology of seventy species of Braconidae is in the press as an *Indian Forest Record ;* 13 of these parasitise *machaeralis* and six others *puera*.

Predators of teak defoliators.—Additional species of mantid predators have been found including *Ephestia intermedia, Dysaules himalayensis, Hetiasula brunneriana* and *Schizocephala* sp.; these have two generations a year. The life-histories of predaceous reduviid bugs *Acanthaspis* sp., and *Sycanus collaris* have been studied; the latter has two generations a year. Among the spiders being bred is one species that has lived for nearly three years hatching in June 1932, moulting 8 times, and ovipositing in June 1934.

The parasites and predators of all other species of forest insects reared at Dehra Dun have received attention. In the case of the hymenopterous parasites of species of *Dinoderus* (Bostrychidae) statistical data show that the adult population of parasites in a bamboo depot is about one-fifth of the adult population of borers, while the adult population of clerid and histerid predators amounts to less than one fiftieth of the adult borer population; but where conditions remain undisturbed the natural enemy population eventually outnumbers the borers.

General Insectary Work.

During the year 184 consignments of attacked material and insect specimens were received from various forest divisions in India for identification, etc. In the Insectary 149 cages were discontinued, and 550 were in progress. The total number of insects bred out was 24,371 of which 14,297 were set and labelled. Large quantities of material were in addition dealt with in the laboratories.

A *Record* on the biology of the Psyllidae was sent to press. Thirty-four species attacking thirty-one forest trees were studied to determine the number and sequence of generations in this group. The gall formers include species with one and two generations per annum as well as some with eight. The forms living freely on leaves pass through as many as eleven generations.

Systematic Entomology.

During the year, 570 species, many of them new to science, have been added to the reference collection of identified insects. An outstanding feature is the friendly co-operation existing with numerous specialists in various parts of the world, which results in a rapidly increasing knowledge of the insect fauna of Indian forests out of all proportion to the actual size of this section. Acknowledgment is especially due to the Imperial Institute of Entomology for assistance in many ways, particularly for arranging the identification of the numerous parasites reared in association with biological investigations in past years. The Director, Sir G. A. K. Marshall, has himself given much of his valuable time to the identification of the great numbers of Cur-

culionidae whose names were urgently required in connection with studies being made at this Institute.

Numerous studies based on our material have appeared in *Indian Forest Records* and in other well-known scientific publications.

The Systematic Entomologist has continued to concentrate on the classification of the immature stages of the Coleoptera with special reference to xylophagous species. Several papers on the subject have been prepared for the press including one on the identification of larvae of the Scarabaeoidea, a group including many soil-inhabiting species which are pests of considerable importance in forest nurseries. There is now a large collection of larval dissections permanently mounted on microscopic slides in addition to a representative spirit collection.

Tours.—By Dr. Beeson to Simla in May; to Kulu, Punjab in May-June; to Ranchi in November and March (Lac Cess Committee); to Calcutta in November; to Delhi in February (Imperial Sericultural Committee). By Mr. Gardner to Chakrata, United Provinces in May-June. By Mr. N. C. Chatterjee to Kalimpong, Jalpaiguri and Kurseong, Bengal, in August-September. By Mr. S. N. Chatterjee to Puri, and Angul, Bihar and Orissa, Seoni, Jubbulpore and Saugor, Central Provinces in May-July. By Mr. B. M. Bhatia to Kulu, United Provinces in May-June; to Landsowne, United Provinces in August and October. By B. Gauri Dutt to Ceylon in November to January.

Museums.—The chief accessions to the entomological museum were 155 examples of damage to timbers by borers. In view of the renewal of educational courses at the Forest College the Zoological museum has received new exhibits.

Library.—143 books besides periodicals were added to the Zoological Library during the year.

CHAPTER V.—ECONOMIC BRANCH.

Wood Technology Section.

1. Research.

(*a*) Bulletin No. 84, entitled "Identification of the commercial timbers of the Punjab" was published during the year. Work in connection with the preparation of hand lens keys for Assam and Bengal was taken up. The object is to give in these bulletins up-to-date information regarding anatomical structure, with short notes on strength, seasoning properties, durability, working qualities, supply and uses of the commercial timbers of the provinces, with a view to make the publications as useful as possible to all interested in the timber-trade.

(*b*) Studies in the formation of growth rings in the woods of *Acacia catechu, Bombax malabaricum, Eugenia jambolana, Pinus longifolia, Shorea robusta, Tectona grandis* and *Terminalia tomentosa* were continued during the year. Wood blocks of *Acacia catechu, Pinus longifolia, Shorea robusta, Tectona grandis* and *Terminalia tomentosa* were cut and studied. During the coming year the remaining species will be critically studied.

Further observations were made on the initial distribution of parenchyma cells found in the *Terminalia tomentosa*. Results so far obtained have been very interesting and notes on this subject will be published shortly.

(*c*) Research on the anatomical study of the wood of Indian Dipterocarps was continued during the year. All the Indian species have been cut and mounted, and are now ready for critical study. Along with this study it has been thought advisable to make a general anatomical survey of the family *Dipterocarpaceae*. With this object in view authentic specimens of foreign Dipterocarps were obtained. These specimens will be carefully studied in due course.

(*d*) A preliminary investigation was carried out on the fluorescence in wood under ultra-violet light. For this purpose only a few Indian species were selected. The results obtained showed some possibility of their application for the purpose of identification and a short note was published in "Current Science", August 1934. A fuller account of the work is now in the press. This work was done in co-operation with the Chemistry Branch.

(*e*) The study of the different varieties of *Terminalia tomentosa* was continued during the year. It has been found that figured wood is not confined to any particular variety of laurel. The presence of figure in different varieties is erratic. Even in the same log figure may be found

in a few growth rings and may be entirely absent in the rest of the log. This investigation is not yet complete. In this connection it has been thought advisable to examine the various species of *Terminalia* in order to make this study as complete as possible.

(*f*) Study on the relationship between the anatomical structure and the physical properties of *Tectona grandis* (teak) from Burma was continued. The wood samples originally sent from Burma were found to be inadequate for this investigation. A tentative report based on the study of the ninty-one specimens has been sent to the Forest Economist, Burma, with suggestions for the selection of samples for future examination, if further investigation is desired.

(*g*) A study of the woods of the Indian *Meliaceae* (mahogany family) was continued. Up to date 34 wood specimens, from the collection of the Forest Research Institute, have been cut and mounted. More specimens will be cut and studied during the current year.

2. Identification of Woods.

As usual, a large number of timbers was received from various sources for identification. Among these the most interesting were 4 fossil woods sent by Mr. C. S. Purkayastha of the Assam Forest Service. The fossil No. 2 has been identified. It shows similarity in general features and in minute anatomy to living *Gluta* species of the *Anacardiaceae*. The name *Glutoxylon assamica* has, therefore, been proposed in a short note entitled "A fossil dicotyledonous wood from Assam", published in "Current Science", December 1934. A fuller account is under preparation and will be published soon.

The total number of timbers identified during the year was about 400.

3. Examination for Fungus.

Various enquirers sent samples of wood suspected of having been attacked by fungus. The number of specific enquiries replied to in this connection was 31.

4. Special Enquiries.

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for several business firms. In this connection 203 wood specimens were examined.

5. Indexing permanent slides and anatomical data.

In the course of routine work permanent slides were prepared from about 400 wood specimens. Whenever possible anatomical data have been collected from these slides and filed for future reference.

6. Collection of authentic wood specimens.

(*a*) *In India.*—Several authentic wood specimens were received for the standard collection.

(*b*) *From abroad.*—During the year altogether 367 wood specimens were received. Of these more than half were from Dr. H. P. Brown, Syracuse University, U. S. A. Other donors were Dr. L. Chalk, Imperial Forestry Institute, Oxford; Mr. B. J. Rendle, Forest Products Laboratory, England; Mr. H. E. Desch, Forest Research Institute, Malaya; Prof. S. J. Record, Yale University, U. S. A.; Directors, Field Museum of Natural History, Chicago; Forest Products Laboratory, Canada and the Chief of Forest Products, South Africa. Our sincere thanks are due to the above donors for helping the Forest Research Institute to make a complete collection of the commercial timbers of the world.

7. Distribution of Wood Specimens.

In response to requests from abroad and from various parts of India, 500 samples of timber were sent out to interested enquirers.

8. General.

A short course in Wood Technology was given to the following officer:—

Mr. Jayawardana, Assistant Conservator of Forests, Ceylon.

Over 20 photomicrographs were sent to various persons interested in wood identification.

9. Publications.

See Appendix I.

Timber Testing Section.

1. Staff.

Mr. L. N. Seaman held charge of the Section for the first eleven months. Mr. V. D. Limaye, Assistant in Charge, was sent on deputation to England and America by the Government of India in order to study Timber Testing methods in other countries. He visited the Laboratories at Princes Risborough, Paris, Ottawa, Madison, Vancouver, Manila, and Kuala Lumpur and saw logging operations in Vancouver, Federated Malaya States and in Burma. He also visited a number of lumber mills and wood working industries. After his return from deputation Mr. Limaye took officiating charge of the Section when Mr. Seaman proceeded on leave on the 6th of March and held charge till the end of the year.

2. Special Investigations.

(*a*) The study of the influence of friction on the results obtained with the standard shearing test tool was continued. The effect of the shape of the test specimen and the method of holding it in the tool is also being studied. The examination is not yet complete.

(*b*) *Cleistanthus collinus* and *Eucalyptus rostrata* poles were tested for suitability for use in electric transmission lines. Although mechanically they were strong enough the poles split badly while seasoning. Their utility depends on proper seasoning.

(*c*) *Fraxinus micrantha* from the United Provinces and mulberry from Changa Manga and Khanewal Plantations were tested for suitability for sports goods. Both of these were found to be as good as imported ash for this purpose.

(*d*) Tests were made in conjunction with the Seasoning Section to find the effect on strength of different treatments given to wood before seasoning. *Hopea parviflora*, *Anogeissus latifolia*, *Terminalia tomentosa*, *Xylia xylocarpa*, *Grewia tiliaefolia*, *Stereospermum xylocarpum* were tested. The investigation is still in progress.

(*e*) Different lots of sissoo (*Dalbergia sissoo*) from the Punjab, *viz.*, Changa Manga, Punjab Roadside, and River island sissoo, etc., were tested and compared for strength. A report on this will be issued in due course.

(*f*) Different lots of teak such as wide ringed teak, light and dark coloured teak, gum streaked teak, etc., were tested and compared for strength with normal teak. It was found that the quality of teak was reasonably good when the growth rate was anywhere between 4 and 20 rings per inch. It was also noticed that the colour had no significant effect upon strength.

(*g*) Wood used in aircraft construction and samples obtained from failures of aeroplanes were tested from time to time as required.

(*h*) 21 consignments of glue joints submitted by Ground Engineers of different Flying Clubs were examined and reported on to the Director of Civil Aviation in India.

(*i*) The Timber Sections of the Military Engineers' Handbook were re-written and a description of 45 species of wood together with working stresses and other tables were added.

(*j*) The Officer in Charge paid a visit to Rangoon to attend a Conference on the subject of Teak Grading. Data were obtained on more than 6,300 teak squares and from the analysis, grading rules were prepared in consultation with the lessees, the Burma Forest Department and the Timber Advisory Officer with the Railway Board. These grading rules are now being considered in detail by the teak lessees and the

Forest Economist, Burma. When the rules are finally approved and brought into force it will be possible to grade teak squares on the market in a more uniform manner and buyers will be able to select a definite grade according to requirements. These grades do not apply to converted material but to teak squares only as teak is generally sold in the form of squares which are converted by the buyers according to their own requirements.

3. Routine Testing.

During the year under report good progress was made on the routine testing programme although it was somewhat delayed by the necessity for making special tests and by the teak grading work. Work under Project 1 (Standard Tests on Small Clear Specimens) and Project 2 (Standard Tests on Structural Timbers) was continued. Other routine testing such as glues, plywood, containers, etc., was also done in co-operation with the Wood Workshop Section.

No. of species tested during the year.

	Green.	Air Dry.	Kiln Dry.	
Project 1 . . .	9	7	6	
Project 2 . . .	..	4	..	
Project 0 under various subheads . .	..	..	..	73 consignments.

The testing also includes 21 consignments of glue joints submitted by Ground Engineers for examination.

No. of species computed during the year.

	Green.	Air Dry.	Kiln Dry.	
Project 1 . . .	8	6	6	
Project 2 . . .	1	2	..	
Project 0 . . .	..	..	..	69 consignments.

Over 14,000 Mechanical tests and nearly the same number of Physical determinations were made during the year. 4,000 special shrinkage observations were also made in addition to routine computations. Reports on 6,300 teak squares consisting of about 187,000 cubic feet of timber were analysed and numerous tables were prepared involving much computing work for the study of teak grading.

4. Technical notes and advice.

125 technical notes and letters were issued during the year, among which the following may be mentioned :—

1. Comparison of different lots of teak.
2. Comparison of different lots of sissoo.
3. Specifications for Railway Sleepers.
4. Wood suitable for flooring.
5. Indigenous substitutes for walnut for making gun stocks.
6. Wood for cooling towers.
7. Wood suitable for bridge work.
8. Wood for various kinds of handles such as hammer handles, phowrah handles, etc.
9. Wood for sports goods.
10. Wood for transmission poles.
11. Wood for yacht masts.
12. Suitability of wood for Railway floor boards.
13. Wood for cotton reels, shuttles, etc.
14. Indigenous substitutes for polo stick heads.
15. Indigenous substitutes for hickory, ash, birch, maple, and willow.
16. Wood for motor bodies.
17. Species suitable for deck planking.

5. Publications.

See Appendix 1.

Wood Seasoning Section.

1. New Method of Kiln Drying.

Considerable progress was made with the new method of kiln drying developed at this Institute. During the year, 29 charges of timber covering 16 species were dried in the two small internal fan kilns, and except in the case of 2 species, namely *Shorea robusta* and *Schima wallichii*, the results obtained were quite satisfactory. Owing to insufficient supplies of suitable timbers, only 4 kiln charges were undertaken in the large kilns, and results in all the cases were highly successful. One inch thick planks of *Cedrela toona* were dried from about 95 per cent. to 10 per cent. moisture content in 8 days. The timber was

of very poor quality, from road-side trees of irregular growth, having numerous decayed knots, occluded bark and cross grain. In spite of this, the increase in degrade was negligible, being confined to some collapse around decayed knots, and some warping and twisting of wide tangential planks. A charge of *Amoora wallichii*, one inch planks, was dried from about 70 per cent. to 9 per cent. moisture content, taking 9 days in all, and the condition of the timber at the end of drying was excellent. The final tests indicated an almost entire absence of drying stresses, and a very uniform moisture distribution in the wood. A mixed charge of *Dipterocarpus turbinatus*, *Dichopsis elliptica*, *Hardwickia pinnata*, and *Hopea parviflora* was very successfully dried. *Dipterocarpus turbinatus* (gurjun) contained as much as 120 per cent. moisture, the planks being up to 28 inches wide. At the end of 20 days, the average moisture content for the whole lot was 10 per cent. and even the widest gurjun planks did not have more than 11-6 per cent. moisture. The results obtained in all these cases are a considerable improvement on the old process of drying, giving a better quality of dried material at a lower cost.

A note on the kiln drying of laurel (*Terminalia tomentosa*) according to the new process of kiln drying was published in the August 1934 issue of the *Indian Forester*, which evoked a number of enquiries from India and abroad. Another short note on the new method of drying has been published in the March 1935 issue of the *Hardwood Record* of Chicago, U. S. A. A detailed analysis of the results so far obtained with this method will be published shortly as a Forest Bulletin.

It is gratifying to note that there is an increase in the number of enquiries about the design of timber seasoning kilns. Drawings and specifications were supplied to a number of enquirers, and out of these 3 firms in Assam, Bengal and Madras have decided to put up kiln drying installations during the coming year.

2. Furnace Kiln.

At the close of the year, the erection of the furnace and of the accessory plant was completed and one charge of white dhup, *Canarium euphyllum*, 1 inch thick planks was successfully dried from the green condition to about 10 per cent. moisture content. Except for a slight discoloration of the wood due to unburnt smoke, which was entirely removed by planing, there was no degrade whatsoever.

The chief advantage of this kiln is that it is independent of a steam boiler and can be worked entirely on wood refuse and sawmill waste. Some kind of motive power is, however, required for working the centrifugal fan, which delivers the hot gases from the furnace to the kiln. Temperature can be controlled by regulation of fresh air to the generator

and the humidity by means of water sprays. Further tests with this kiln will be carried out during the coming year and a detailed report will be issued.

3. Kiln Drying with Ozone.

Experiments were completed last year and it was found that addition of ozone to the air circulating in a kiln did not have any effect on the rate of drying or on the shrinkage of any of the four species tested. A detailed report has been issued as Indian Forest Records, Vol. XX, Part XIII, "Results of Experiments on the Kiln Drying of Wood with Ozonized Air".

4. Drying under Vacuum.

No further experiments could be carried out during this year. It is, however, interesting to note that an oak sleeper was sent to this Institute by a Swedish firm, which they stated had been dried under vacuum to a moisture content of 12 per cent. in 35 hours. On testing it was found that the sleeper contained on an average 27 per cent. moisture, with a gradient of 13 per cent. in the surface layers to 45 per cent. in the interior. The weight of the sleeper during transit came down from 80 Kg. to 64 Kg., which would give an initial moisture content of about 60 per cent. at the time the sleeper was despatched. It is not unusual to find claims of this nature made which are not verified after careful examination in the Institute.

5. Air Seasoning.

Final observations were taken on all the air seasoning experiments that were in progress at the beginning of the year, and the results were incorporated in the "Manual on Air Seasoning of Indian Timbers", published during the year.

Further studies on the air-seasoning of some of the highly refractory species were undertaken, which included the following among others :—

(i) *Eugenia gardneri.*

(ii) *Hopea parviflora.*

(iii) *Quercus lamellosa.*

(iv) *Quercus lineata.*

(v) *Schima wallichii.*

In order to slow down the rate of seasoning, the timber was stacked with very thin crossers, and even without crossers at all. Results with *Hopea parviflora* and *Quercus lamellosa* appear to be promising so far, in stacks without any crossers.

6. Water soaking prior to air-seasoning.

An experiment on the water soaking of the following timbers for periods varying from 1 to 5 years was started during the year :—

(i) *Amoora wallichii.*

(ii) *Anogeissus latifolia.*

(iii) *Eugenia gardneri.*

(iv) *Hopea parviflora.*

(v) *Quercus lamellosa.*

(vi) *Quercus lineata.*

Matched material of the following species, air seasoned with and without previous water immersion, was sent to the Timber Testing Section, for determining the strength under impact, in order to find out whether water soaking has any adverse effect on this property :—

(i) *Anogeissus latifolia.*

(ii) *Eugenia gardneri.*

(iii) *Grewia tiliaefolia.*

(iv) *Hopea parviflora.*

(v) *Stereospermum xylocarpum.*

(vi) *Xylia xylocarpa.*

7. Air Seasoning of Railway Sleepers.

The experiment on the air seasoning of Railway sleepers, started at Dhilwan during the previous year, in co-operation with the North Western Railway and the Punjab Forest Department, was continued till the middle of November 1934, when the final observations were taken. During the dry summer months, March to June, one-third of the number of sleepers was stacked in the "1 and 9" method and the rest in close crib stacks. In the first week of July, all the sleepers were inspected for development of defects and moisture loss, and were passed by a Railway Sleeper Passing Officer. The sleepers were then re-stacked in the "1 and 9" method, as, during the monsoon, the close crib stacking was considered to be hazardous, on account of the liability to decay and fungus attack. The final inspection and passing were carried out in the middle of November 1934. A preliminary report on the results obtained in this experiment was published in the *Indian Forester* of July 1934, and the final report will shortly be issued as a Forest Bulletin. From the data obtained in the experiment, the following general conclusions can be drawn, which are substantially the same as those reported last year.

1. *End-tarring.*—The ends of all the sleepers should be given a thick coating of coal-tar or of some other suitable material as soon as possible after the sleepers are taken out of the water.

2. *Stacking.*—Deodar and fir sleepers can be stacked either in the "1 and 9" or in the close crib manner, from the beginning to the end of dry weather, provided the ends of sleepers are well protected against too rapid drying. Chir sleepers should be stacked in the "1 and 9" method, on account of their liability to decay and fungus attack.

3. *Seasoning period.*—Softwood sleepers after their arrival at depots in the plains require about a year for complete seasoning. In the case of deodar sleepers, which may be used in the line without antiseptic treatment, it is necessary that seasoning should be carried out for this period under controlled conditions.

Another experiment on the seasoning of sleepers was carried out at Marala in co-operation with Messrs. Spedding, Dinga Singh & Co. Two thousand deodar sleepers were stacked at the end of April 1934, in order to find out the effect of end-tarring and to compare the "1 and 9" and the close crib methods. The experiment had to be discontinued in the 2nd week of July 1934 and the results were disappointing. At the end of two months, the percentage of rejections due to seasoning defects amounted to 17 per cent. and there was no significant difference between the sleepers stacked in the "1 and 9" and the close crib manner. End-tarring was also ineffective in preventing the end cracking of sleepers. The only conclusion that can be drawn from this experiment is that it is difficult to find any practical method, other than the erection of costly air seasoning sheds, which would prevent heavy damage during seasoning, if the sleepers arrive during the dry weather.

In this connection the Officer in Charge paid a visit to some timber exploitation works in the Kulu forests in September 1934, in order to study the method of conversion and extraction of sleepers. As a result of this tour a number of suggestions were offered for the consideration of the Punjab Forest Department, and during the following year it has been decided to carry out an experiment in the Upper Bashahr Division to determine the effect of seasoning sleepers in the forests for various periods before launching.

8. Laboratory Experiments.

1. *Methods of moisture determination.*—The work on this item was completed last year and a paper was written up, which will be published in the *Empire Forestry Journal.*

Some preliminary experiments were carried out on testing the accuracy of the Tag-Heppenstall and the "Blinker" moisture meters

and a detailed note on the methods of rapid determination of moisture content of wood has been sent to the *Indian Forester* for publication.

2. *Shrinkage and Hygroscopicity Experiments.*—Work on the seven species taken up during the last two years was completed and a detailed study of the following species was taken in hand during the year :—

1. *Tectona grandis*, teak, ungirdled from Burma.
2. *Tectona grandis*, teak, girdled from Burma.
3. *Dalbergia sissoo*, sissoo.
4. *Cedrela toona*, toon.
5. *Eucalyptus eugenioides.*

Various experiments have been carried out during the year to determine the effect on shrinkage, swelling and hygroscopicity of woods after the following treatments.

1. Impregnation with various chemicals.
2. Boiling in water.
3. Steaming at various pressures for different periods.
4. Exposing wood to high temperature and low humidity for long periods.
5. Metal spraying of wood.
6. Kiln drying under varying conditions of temperature and humidity.

The results of these experiments are being worked up and will be published during the coming year.

9. Enquiries.

A large number of enquiries on various subjects relating to the air and kiln drying of timbers was replied to as usual. As mentioned before, kiln drying is receiving increasing attention in the country, as can be judged from the number of enquirers who want information on the design and erection of kilns.

10. Publications.

See Appendix I.

Wood Preservation Section.

Mr. S. Kamesam held charge of the Section throughout the year except for a period of one month when his services were lent on deputation to the Travancore State.

1. The Raman Committee Report on Ascu wood preservative.

Reference was made in last year's report to an investigation of the Ascu wood preservative by a special committee appointed by the Railway Board. The committee re-assembled in Simla in June 1934. After a three days' session, the committee signed a unanimous report on the Ascu wood preservative. The report has been published under the title of "Report of the Committee appointed by the Railway Board to report on the Suitability of the Falkamesam Preservative for treating timber".

The Committee agreed that Ascu could be considered "to be an improvement on the present method of treating sleepers and expected to show a saving in cost". They required assurance that Ascu treated sleepers would not be liable to split any more than those treated at present with the oil creosote process.

The Committee recommended that 25,000 sleepers each of deodar, chir, fir, kail, hollock and hollong should be treated with Ascu under pressure, and also with a special anti-splitting medium consisting of a bituminous suspension. This recommendation was accepted by the Railway Board. It is obvious from the report that as far as the efficacy of Ascu as a wood preservative was concerned, the Committee was satisfied. The Committee considered that periodical observations and reports on these Ascu treated sleepers compared with others of the same species in the same locality treated by the ordinary oil creosote process during the next two or three years "should be capable of furnishing material for a final decision as between the Ascu preservative and the existing method of treatment".

2. Large scale field experiments by the Indian Railways.

After the publication of the Raman Committee Report in July 1934 the Director of Civil Engineering, Railway Board, accompanied by the Secretary of the Raman Committee visited the Wood Preservation Section when details regarding the preliminary experiments that were to be made for carrying out the recommendations of the Raman Committee were discussed. A definite programme of work was drawn up for deriving the proper specifications for the treatment (of the lakh and a half of experimental sleepers) with Ascu and with a bituminous suspension.

The preliminary tests were concluded about the end of November 1934 when a detailed report on the results obtained was prepared, along with definite recommendations based on them, and presented to the Railway Board. The Director of Civil Engineering accompanied by the Joint Timber Advisory Officer to the Railway Board and the Army

Departments again visited the Wood Preservation Section in the third week of December 1934 to inspect the sleepers treated in the preliminary tests and to discuss the procedure for carrying out the large scale test.

The recommendations made regarding the Ascu and anti-splitting treatments of the six species concerned were accepted by the Railway Board. In March, 1935, it was decided that about 14,400 B. G. coniferous sleepers should be treated at an early date with Ascu and the anti-splitting medium. This comparatively small number was chosen for the first year by representatives of the Railway Board, the Forest Research Institute and the North Western Railway in order to dislocate to a minimum the sleeper renewal programme of the North Western Railway during 1935-36, and also to see whether there would be any unforeseen difficulties encountered in the actual treatment of a large number of sleepers with Ascu. It is confidently expected that a very much larger number will be treated next year.

3. Specifications for the Ascu and anti-splitting treatment of the six species.

Chir, fir, deodar and blue-pine will be treated by the Rueping process with two concentrations of Ascu solution, *viz.*, 8 per cent. and 4 per cent. hollock will be treated by the Lowry process with the same concentrations. The first three species will be treated with an initial air pressure of 50 lbs. sq. in. whereas with blue-pine the pressure will be 75 lbs. sq. in. In the case of hollong sleepers, the Lowry process will be employed using two concentrations of the preservative, *viz.*,4 per cent. and 2 per cent. The anti-splitting treatment in the case of chir, blue-pine and hollong will consist of 5 minutes' immersion in a hot 10 per cent. asphaltic suspension in crude oil. In the case of hollock and incised silver fir the period of immersion will be 10 minutes, whereas with deodar, the period will be 15 minutes. One half of the Ascu treated sleepers for each of the two concentrations will be treated by the above specification against splitting. The other half in each case will be treated with precisely the same bituminous composition but the period of immersion will be double that in the previous case.

4. Practical application of the Ascu wood preservative.

(i) During the year the Government of the United Provinces, represented by the Irrigation Department, accepted the use of Ascu for preserving sapwood timber poles for the transmission of electricity at 11 K. V. in the Meerut grid area. It is expected that within the next year, a few hundred miles of such rural distribution lines will be installed.

(ii) The Officer in Charge of the Section examined the timber resources of Travancore and made several recommendations to the Government for the exploitation of the State's timber resources, preferably after treatment with Ascu. Practically all the recommendations, including the Ascu wood preservative, on which the recommendations are based, have since been accepted by the Government. The most important of these is the immediate use of Ascu treated timber poles in connection with the Pallivasal Hydro-electric scheme. A plant is being installed by the Travancore Government for operating the Ascu process to treat several thousand poles both for electrical transmission, distribution and telephone construction.

(iii) The Government of Mysore has officially accepted the Ascu preservative. They are treating over 20,000 c. ft. of timber in the form of poles and sleepers during the current year with Ascu.

(iv) The Government of Bhopal have also accepted the Ascu wood preservative, and Mr. Kamesam will be shortly deputed to the Bhopal State for doing work similar to that done for Mysore and Travancore.

(v) The Government of Madras have brought into operation two pressure plants employing Ascu as the wood preservative. They are under the supervision of the Director of Agriculture and the Director of Fisheries.

(vi) The first private commercial wood preservation plant in India was ready by March, 1935. It was put up by the Ascu Wood Preserving Agency, Dehra Dun, who are the sole licensees of the Ascu patent in India. It is understood that during the next few months they will have three or four pressure plants operating in Northern India. The Agency has been commissioned to preserve with Ascu a thousand 36 feet long blue pine poles for the electrification of a well-known Punjab hill station, besides four thousand poles for the United Provinces Government. It is understood that the Agency will shortly put up two more Ascu plants.

5. Further results of veneer and bamboo tests.

Some important results obtained by employing veneer test pieces treated with different wood preservatives were mentioned in last year's report. The Raman Committee report contains much data of value obtained by this technique. Ascu treated bamboos have given very satisfactory results, being intact after 15 months in a very severely white-ant and fungus infested area in which the untreated controls perished in a short time.

6. Fire-proofing treatment with Ascu.

Preliminary experiments to evolve a one movement fire-proofing and Ascu treatment were made, with fair degree of success, about the

close of the year; it appears that the incorporation with Ascu of ammonium sulphate, which is one of the cheapest fire-proofing chemicals known, provides an efficient combined fire-proofing, termite and rot proofing treatment. Experiments are in progress to perfect the process so that it can be used in commercial plants.

7. Anti-splitting treatment of timber with bituminous emulsions.

Recent experimental results as well as patent literature on the subject show that petroleum asphalt is one of the most efficient and economical anti-splitting media known. Instead of employing the asphalt as a suspension in crude oil, it is proposed to employ it after emulsification with water. The crude oil as a medium to spread asphalt on timber is expensive compared with water as an emulsifier. Preliminary experiments in this direction were made with success at the close of the year. The two chief advantages of the bituminous emulsion over a suspension in crude oil are, firstly, no heat will be required in the field for the application of the asphaltic anti-splitting treatment, and secondly, the treatment, for the same asphaltic content, may be expected to be about 25 per cent. cheaper than an asphaltic suspension in crude oil.

8. Project IV and Grave Yard Tests.

198 B. G. sleepers of *Parashorea stellata* from Burma were treated and handed over to the East Indian Railway for durability trials.

During the year the following were added to the timber test yard of the Section ;—

(i) Treetex.

(ii) Insulation Board.

(iii) Parnlac 148.

(iv) Ascu treated and untreated sapwood posts of chir and teak with and without water-proofing butt treatments.

(v) A dozen sticks of each of the six species of timbers (chir, fir, deodar, kail, hollock and hollong) treated with different concentrations of Ascu along with control specimens treated with 40 per cent. creosote and 60 per cent. earth oil.

(vi) Cross-Sections from Ascu treated sleepers.

(vii) Specimens treated with Cuprinol.

Untreated specimens of the three following species of timber were also added during the year :—

(i) *Butea frondosa*.

(ii) *Phoebe* spp.

(iii) *Eucalyptus* spp.

9. Marine tests.

Ascu treated chir sapling posts along with untreated controls were sent to the harbours of Calcutta, Vizagapatam, Madras, Bombay and Karachi for exposure to marine organisms.

10. Tours.

The Officer in Charge inspected experimental sleepers installed in the Bengal Nagpur Railway, Madras and Southern Mahratta Railway, and marine specimens in the Calcutta, Vizagapatam and Madras harbours. After exposure to marine organisms for 18 months the Falkamesam and Ascu treated specimens were observed to be absolutely intact while the untreated controls were either entirely destroyed or badly attacked.

11. Publications.

Forest Bulletin No. 85 entitled " A Record of the Results obtained with Experimental Treated Sleepers laid in the Indian Railways between 1911 and 1916 " came out of the press during the year.

Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other Sections, while the Officer in Charge devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 14,328 wood specimens for test purposes.

The Wood Technology Section was supplied with 41 Gamble and 713 hand specimens and 14 cubes for specific gravity tests.

563 orders of maintenance and routine work were completed during the year.

221 logs of the following species were converted in the Saw-mill :—

Alnus nepalensis for strength tests.

Anthocephalus cadamba for strength tests.

Fraxinus macrantha for strength tests.

Morus alba for strength tests.

Butea frondosa for strength tests.

Phoebe spp. for strength tests.

Dalbergia sissoo for strength tests.

Cryptomeria japonica for strength tests.

Eucalyptus euginoides for strength tests.

Tectona grandis for strength tests.

Shorea robusta for strength tests

Terminalia tomentosa for seasoning tests.

Cedrela toona for seasoning tests.

Anogeissus latifolia for seasoning tests.

Amoora wallichii for seasoning tests.

Terminalia paniculata for seasoning tests.

Quercus lineata for seasoning tests.

Quercus lamellosa for seasoning tests.

Hopea parviflora for seasoning tests.

Eugenia gardneri for seasoning tests.

Dichopsis elliptica for seasoning tests.

Hardwickia pinnata for seasoning tests.

Schima wallichii for seasoning tests.

Terminalia bialata for seasoning tests.

Canarium euphyllum for seasoning tests.

Dipterocarpus alatus for veneer tests.

Lophopetalum wightianum for veneer tests.

Dipterocarpus turbinatus for veneer tests.

Dipterocarpus tuberculatus for veneer tests.

Pinus longifolia for General use in Wood Workshop Section.

Anisoptera glabra for General use in Wood Workshop Section.

Mangifera indica for General use in Wood Workshop Section.

Abies pindrow for General use in Wood Workshop Section.

In addition to the above, 246 paving blocks were prepared from old sleepers for the Wood Preservation Section, 12 sleepers were converted into shingles, 25 sleepers into scantlings, 2 pieces sleepers into planks for the Wood Preservation Section, 350 bullies cut into halves for the President, Forest Research Institute, branches of *Mangifera indica* converted for making charcoal for the Minor Forest Products Section.

Reports on the working qualities of the undermentioned timbers were issued during the period under review :—

Dalbergia latifolia (rosewood).

Lagerstroemia lanceolata (benteak).

Mallotus philippinensis (roini).

Miliusa velutina (domsal).

Alnus nepalensis (Indian alder) kiln dried.

Dalbergia sissoo (Punjab roadside sissoo).

Cryptomeria japonica (dhupi).

Phoebe spp. (mekahi).

Butea frondosa (dhak).

Anthocephalus cadamba (kadam).

Alnus nepalensis (Indian alder) air dried.

A large number of enquiries were received from various sources and were replied to.

Veneer Sub-Section.—The Veneer Sub-Section was closed down up to 2nd November 1934 owing to the absence of the Officer in Charge on long leave.

Logs of the following species were peeled for tests under Project VIII on return of the Officer in Charge :—

Terminalia tomentosa (Burma).

Dipterocarpus alatus (Burma).

Tamarix articulata (Punjab).

Machilus macrantha (Mysore).

Cryptomeria japonica (Bengal).

Dipterocarpus turbinatus (Burma).

Lophopetalum wightianum (Madras).

Tests.

Tests on glues were carried out as follows and results submitted to :—

1. Messrs. The Swastika Chemical Co., Saharanpur, United Provinces, on a sample of Casein.
2. The Director of Civil Aviation in India, New Delhi, on glue joints to find out deterioration by fungal growth.
3. The Assistant Aircraft Inspector, Dum Dum, Calcutta, on a sample of glue.

Tests were also carried out on various fillers for open joints on parquet floor, glue and saw dust, glue and chalk, plastic wood, and plastic wood and chalk. Glue and saw dust appeared to be the cheapest and best.

Numerous enquiries relating to veneers, plywood and glues were received during the year and dealt with.

Reports.

An Interim Report on the work done up to the end of 1933 under Project VIII (Testing of Veneers and Plywood) has been published. This

Interim Report has been reviewed favourably by the Press and experts both in India and abroad and there now appears every hope of the plywood industry materializing in India.

Minor Forest Products Section.

1. General.

The Forest Economist is nominally in charge of this Section, and the total staff of the Section consists of one Upper Grade Assistant (Mr. Ramaswami), one laboratory assistant and a few coolies. With such a staff very little research work can be accomplished.

2. F. R. I. Portable Charcoal Kiln ("Frikiln").

A note embodying the details of the working of the "Frikiln" was published in the "Indian Forester" (January 1935). Numerous enquiries have been received from forest officers and charcoal contractors for information about this kiln. According to the current prices of materials and labour it has been estimated that the "Frikiln" could not be made for less than Rs. 443 each. As this figure is still considered to be too high, experiments are being made to do away with unnecessary parts without sacrificing the efficiency of the kiln; some success has been attained in this direction in making charcoal in the kiln without using the air-admission apparatus, entry of air into the kiln being controlled through small holes made in the earth at the base of each lower panel; at the end of a burn these holes are closed by banking them up with earth.

3. Charcoal Briquetting.

A charcoal grinding machine (a second hand *soorki* mill) was erected during the year. About 100 lbs. of charcoal is ground and mixed with the binders at each charge, prior to briquetting in the rotary press. As the result of these large scale experiments, the following results have been obtained :—

1. Good briquettes can be made using 5 per cent. of *Bauhinia retusa* gum and 4 per cent. of rice flour (boiled in 30-40 per cent. of water). This confirms the results of the previous small scale experiments. These briquettes burn well and do not break easily.
2. The cost of manufacturing briquettes by the above method works out at about 8 annas per maund of 80 lbs.
3. Briquettes are wet when freshly made and in small scale experiments these were spread out in a thin layer on a cement

floor for drying. When several tons of briquettes are made in a day, special drying chambers will be necessary and this will naturally increase the cost of briquetting.

4. The search for a cheaper binder becomes a necessity to compensate for the cost of drying. Experiments in this direction will be conducted in the following year.

4. Minor Forest Products Garden—Cultivation of medicinal plants.

As mentioned in last year's annual report, a list of medicinal plants suitable for cultivation in the Minor Forest Products Garden was prepared and approved by Lt.-Col. Chopra, Professor of Pharmacology, in the School of Tropical Medicine, Calcutta; out of this a start was made with about a dozen plants.

As mentioned in the previous report, experiments on the propagation of *Artemisia maritima* by stem cuttings as well as by root and shoot cuttings were continued during the year. The cuttings planted during the previous year survived the monsoon without casualties and produced seeds during the winter, whereas numerous seedlings put out as control in the same bed have died. Cuttings are best planted in March in Dehra Dun; in the plains it may have to be done a month earlier.

Cuttings of *Derris elliptica* and *Derris malaccensis*, from the roots of of which the insecticide rotenone is prepared, were obtained from Malaya and planted in the Garden Nursery. Only 4 per cent. of the former and 28 per cent. of the latter have survived. The heavy mortality was possibly due to the unusually severe winter.

Chrysanthemum cinerariaefolium (pyrethrum) started flowering at the close of the year (end of March). Regeneration by off-shoots made before the plants flowered was tried and found to be successful.

Psyllium sown in October-November 1933 gave a good yield of seeds and its cultivation was continued during the year in larger beds. The plants were flowering at the close of the year.

5. Match Woods.

A note on Indian Timbers tested for match manufacture was prepared. Tests carried out in this Institute as well as by various match factories in India have been incorporated in the note.

6. Collection of information on the drugs of forest importance.

This work was carried out in conjunction with the Bio-chemist and the Forest Botanist, and the actual collection of information was finished at the close of the year and the work of arranging it has been taken up.

7. Enquiries.

During the year over 250 enquiries from Forest officers, contractors, exporters and others from India and abroad, dealing with the supply, collection, marketing, prices, etc., of various minor forest products of India were answered.

Paper Pulp Section.

1. Experimental Factory.

(*a*) *Disintegration of bamboos.*—Experiments on the disintegration of bamboos in the Norris and Christy machine were continued in the year under report. In order to obtain satisfactory chips, it was found necessary to have on the machine a suitable automatic feeding arrangement for bamboos. This has been designed and is being made by the Mechanical Engineer of the Institute.

(*b*) *Dendrocalamus hamiltonii* (*kokua*) and *Oxytenanthera auriculata* (kalserri) bamboos.—Semi-commercial tests on these bamboos were completed. Sulphate process was employed for the digestion of the bamboos. Both the species were found suitable for the manufacture of a variety of papers. Tests on mixed species of bamboos will be taken up next year.

(*c*) *Pulp for artificial silk.*—Experiments on the production of specially purified pulp for artificial silk production from *Ochlandra brandisii* (eta) and *Melocanna bambusoides* (*muli*) bamboos were carried out throughout the year. Although alpha cellulose content and copper number of the pulps obtained were satisfactory, the viscosity was low in each case. Experiments have to be continued in order to obtain pulp with the requisite characteristics.

(*d*) *Anthistiria gigantea* (ulla grass).—Experiments were carried out on *Anthistiria gigantea* (ulla grass). By adopting a modified overhead sulphate method of digestion it was possible to obtain about 40 per cent. yield of clean bleached pulp, with an economic consumption of chemicals for digestion and bleaching. Very satisfactory qualities of *badami* and white papers were made from the grass pulp by itself and in admixture with small proportions of bamboo pulp. The grass, therefore, appears to be a satisfactory raw material for paper making, and should be useful to supplement the supplies of *sabai* grass in the United Provinces.

(*e*) *Sabai grass.*—Antique papers and imitation art paper were made from *Ischoemum angustifolium* (*sabai* grass) supplied from the Saharanpur Forest Division.

(*f*) *Pinus longifolia* (chir).—Experiments by the sulphate process were carried out on *Pinus longifolia* (*chir*) thinnings from the New Forest

Plantation Area. Although fairly clean unbleached and bleached pulps were obtained, the percentage yields of cellulose were low and the consumption of chemicals correspondingly high. It is proposed to carry out further tests on material obtained from the Almora Division.

(*g*) *Bagasse.*—Experiments were carried out on bagasse (crushed sugar cane) for the production of *badami* and packing papers in admixture with small proportions of bamboo pulp. Fairly satisfactory results were obtained. The use of bagasse for paper making, however, does not appear to be a feasible proposition except in a very few places. It is usually burnt as fuel in sugar factories and in most places the cost of coal or wood fuel makes the corresponding cost of bagasse uneconomic for paper making purposes.

(*h*) *Flax waste.*—The Director of Industries, United Provinces, it is reported, has succeeded in developing a method for separating to a large extent the woody cores from the short fibres. The latter will, therefore, yield a much cleaner pulp without requiring any intermediate grinding of the pulp. Thin white paper, suitable for type-writing purposes, was made from pulp prepared at the Institute from the material.

(*i*) *Manufacture of paper.*—About 3½ tons of writing, printing, type and kraft papers, and mounting and drying boards were manufactured in the factory, of which about 2 tons were supplied to the Manager, Government of India Press and the various offices of the Forest Research Institute and College.

2. Laboratory.

(*a*) *Pulp for artificial silk.*—Determination of alpha cellulose, ash, copper number and cuprammonium viscosity were carried out in connection with samples of purified pulp prepared, both in the factory and the laboratory.

(*b*) *Chemical analyses of raw materials.*—Determinations of cellulose, lignin, pentosans, ash, caustic soda solubility, etc., were made in—

(1) *Dendrocalamus strictus*,

(2) *Bambusa arundinacea*,

(3) *Dendrocalamus hamiltonii*,

(4) *Oxytenanthera auriculata*, and

(5) *Oxytenanthera nigrociliata*.

(*c*) *Autoclave tests.*—These were carried out on *chir* from the Dehra Dun Area and on bagasse.

(*d*) *Nettle fibres.*—Experiments were carried out on the production of papers for currency notes from the material supplied by a private concern.

(*e*) *Bagasse and whole linseed straw.*—Samples of boards were prepared from these materials for the Sugar Technologist and the Director of Industries, United Provinces.

(*f*) *Boiler feed water.*—Routine analytical tests in connection with the softening of the boiler feed water were carried out, as and when required.

3. Tours and enquiries.

(*a*) The Officer-in-Charge, in January 1935, visited the Paper Mills at Kankinara, Naihati and Raniganj, where modern and improved bamboo pulping plants have been put up in recent years. The three mills are now using about 30,000 tons of bamboos per annum and expect considerably to increase the consumption in the near future, as soon as certain initial difficulties have been overcome and the necessary extensions to the plants have been made.

(*b*) Correspondence was carried on with private individuals, commercial firms and Government departments in connection with various technical enquiries referred to the Section.

4. Paper Mills' Conference.

With a view to effect closer co-operation between the Paper Industry and the Paper Pulp Section at the Institute, the President, Forest Research Institute and College, convened a Conference in Calcutta on the 13th and 14th March 1935, at which representatives of all the Paper Mills, operating in this country, attended. The Conference was highly successful and as a result, a scheme of co-operative research work, on problems of direct and immediate interest to the Industry, was laid down. It is hoped that the services of the Paper Pulp Section, working in close co-operation with the Industry, will be of greater utility for the scientific and continued growth of the Pulp and Paper Industry in this country.

MECHANICAL SUB-SECTION.

This auxiliary Sub-Section functioned most satisfactorily throughout the year under the guidance of Mr. Ram Das Tandan, the Mechanical Engineer and B. B. L. Saksena, his Electrical Assistant.

In addition to a large number of daily routine jobs and other petty jobs which cannot be booked in the work order register, there were 500 jobs in all which were completed during the year. The electric installation in the workshops of the Economic Branch, railway trucks and track, lorries, fire appliance, boilers and their attachments, steam pipes and fittings, and plant attached to all Sections of the Economic Branch were all maintained in good order.

A new Furnace Kiln was erected for the Seasoning Section.

Necessary changes were made in the disintegrator in the Paper Pulp Section to improve the grinding of bamboo to the desired quality.

Necessary materials were made for preparing 4 timber-concrete beams and the beams were completed to the desired specification for Timber Testing Section.

A new body was designed and made with the help of the Foreman of the Wood Workshops for the new Chevrolet Bus.

The vacuum cylinder in the Seasoning Section was fitted with a fan, workable by a motor fitted outside.

A *surkhi* grinding mill was received and erected in the Minor Forest Products Workshops for grinding charcoal. As a larger horse power motor was required to drive it, the 15 H. P. motor from the Iron Workshops was erected in place of the 7½ H. P. which was fitted in its place in the Iron Workshops.

A log sinking device was made and fitted to the Log Pond at the Saw Mill.

A new centrifugal pump was received and coupled to be driven by a 5 H. P. motor on the same bed. The pump was connected to the suction and delivery pipe lines laid to draw water from the swimming tank and to feed it to the boiler water treatment tanks.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A.—Drugs :—

i. Plant insecticides.

ii. *Derris* spp.

iii. *Tephrosia purpurea* and *T. villosa.*

iv. *Mundulea suberosa.*

v. *Vitex negundo.*

vi. *Strychnos nux-vomica.*

vii. *Myrsine africana.*

viii. *Artemisia* spp.

ix *Hyoscyamus pussilus.*

B.—Oils and Fats :—

i. *Litsaea zeylanica.*

ii. *Litsaea lanuginosa.*

iii. *Cinnamomum camphora.*

iv. *Melia azedarach.*

v. *Celastrus paniculata.*

C.—Other products :—

i. *Bombax malabaricum.*

2. Study of forest soils.

3. Miscellaneous enquiries :—

i. Fluorescence in wood.

ii. Estimation of arsenic.

I. A.—Drugs.

(i) *Plant insecticides.*—Investigations on plants reputed to act as fish poisons have been continued. Of these, *Derris elliptica, D. malac-*

ccusis and *Caracca* (*Tephrosia*) *virginiana*, have definitely been established to contain rotenone, the active principle, which is responsible for the insecticidal properties. The other constituents such as deguelin, tephrosin, which are present in these plants in varying quantities, also possess the insecticidal properties but to a lesser degree. In order to form a correct estimate of the insecticidal value of such plants, it is essential, therefore, to take deguelin, etc., also into account and not depend upon the rotenone content alone. Hence it has become the practice now to evaluate all such drugs on the basis of their resin content, namely the ether solubles which contain deguelin, tephrosin, etc., rather than on the rotenone content alone. (Haller and La Forge, J. A. C. S., *56*, 2415.)

Very little is known about the Indian plants which might prove of insecticidal value. The following plants are reputed to act as fish poisons—*Antiaris toxicaria* Lesch; *Barringtonia acutangula* Gaertn; *Casearia graveolens* Dalz.; *Cleistanthus collinus* Benth; *Corypha umbraculifera* Linn; *Cyclamen persicum* Miller; *Derris* spp.; *Diospyros paniculata* Dalz.; *Dolichandrone falcata* Seem; *Entada scandens* Benth; *Eremostachys vicaryi* Benth; *Euphorbia tirucalli* Linn; *Flueggea leucopyrus* Wight.; *Lasiosiphon eriocephalus* Dene.; *Maesa indica* Wall; *Millettia atropurpurea* Benth; *Mundulea suberosa* Benth; *Myrica nagi*; *Ougeinia dalbergioides*; *Pithecolobium bigeminum* Benth; *Randia dumetorum* Lam.; *Rhododendron barbatum* Wall; *Sapium indi um* Willd.; *Tephrosia* spp.; *Trichilia trifoliata* Roxb.; *Verbascum thapsus* Linn; *Walsura piscidia* Roxb.

Of these, only a few namely *Derris*, *Tephrosias* and *Mundulea suberosa* have been examined. In examination of these plants chemically, more emphasis has been laid on the total ether solubles in the plant than on the rotenone content itself; since a plant, as discussed above, can possess insecticidal value even when no rotenone can be isolated but is otherwise rich in 'resin' content (ether solubles). It is, however, realised that in all cases the final test is the biological assay, nevertheless it can be said that the plants containing the 'resin' constituents and giving the colour test for substances allied to rotenone are likely to prove of insecticidal value. The above criteria have, therefore, been kept in view in examining the following plants.

(ii) *Derris* spp.—It was reported last year that of the several species of *Derris* found in India only *D. elliptica*, collected in Assam, gave rotenone, whilst in all others no rotenone could be isolated and were very poor in ether extracts even though they gave the characteristic colour reaction (Jones and Smith., Ind. and Eng. Chem. Anal. Ed. V. 75). It was also reported that attempts to isolate other crystalline insecticidal bodies allied to rotenone (deguelin, tephrosin, etc.) were unsuccessful.

purposes." *Tephrosia purpurea* and *T. villosa* have consequently been examined this year and the results are tabulated below.

Species.	Ether solubles.	Rotenone.
T. purpurea—		
roots (thin) a	1·38	*nil.*
b	0·59	„
twigs a.	0 84	„
b.	0 69	„
T. villosa—		
roots	0 95	„
twigs	0·74	„
T. candida	0 90	„

From these it may be concluded that *Tephrosia* spp., hitherto examined, are useless as insecticides.

(iv) *Mundulea suberosa*.—A sample of roots received from Badami range, Southern circle, Bombay, was found to contain 3·8 per cent. of moisture and 4·9 per cent. of ether solubles. Although no rotenone could be isolated, the resins gave the characteristic colour reaction of rotenone and deguelin resins. This species, therefore, although not as good as the Malayan *Derris* is likely to be of some value as an insecticide. The above view, based on the chemical examination alone, is supported by the observation of Tattersfield and Grimingham (Annals of Applied Biology (1932) 19, 253) who found that this species shows a definite activity as a contact insecticide. It would, therefore, be worthwhile to make biological tests on this plant.

(v) *Vitex negundo*.—Preliminary work on the constituents of the leaves of this plant, reported last year, showed that it contained a crystalline polyhydric alcohol m. p. 196°-198°C. Further examination of this substance and its chemical properties support the view that it is a gluco-nonitol. The acid reported to melt at 220°-21°C. on further purification melts at 215°-16°; the drop in its m. p. being due to its contamination with an allied acid of m. p. 285°-87°C. The acid m. p. 215°-16°C forms the main bulk of the free acids and this has now been definitely identified as p. hydroxy benzoic acid, and being an isomer of salicylic acid possesses germicidal properties. The second acid m. p. 184°-85°C reported last year, when further purified by recrystallisation melted at 200°-201°C and its chemical and physical properties indicate

it to be 2 : 5 dioxy benzoic acid. A third acid associated with the acid m. p. 215°-16°C has now been isolated and this like the first acid is sparingly soluble in cold water. It has a melting point of 285°-287°C, sublimes unchanged and from its properties appears to be a hydroxy-isophthalic acid.

Associated with the glucosidal constituent (basic lead acetate precipitate) are two other substances which have not yet been identified and further work on these is in progress. The glucosidal substance itself, however, yields on hydrolysis para-hydroxy benzoic acid and glucose.

(vi) *Strychnos nux-vomica.*—In our previous work on the alkaloidal content of the seeds of *Strychnos* spp. we had overlooked the question of the seasonal variation of the alkaloids in the seeds and this gap in our study has now been filled. The fruits collected from the same tree but at different time, were obtained from different parts of the Madras Presidency. They were in different stages of ripeness, beginning when the seeds were just embryos and ending when they were fully matured. The analytical results have led to the following observations.

1. Alkaloids are present both in the seeds and the pulp even in the very early stages of their growth.
2. As the seeds ripen the alkaloidal content increases.
3. During the process of ripening the pulp loses its alkaloidal content.
4. The alkaloidal content is highest in December.
5. Once the fruit has opened and the seeds fallen out there is no further change in the alkaloidal content.
6. The proportion of the alkaloid is independent of the size of the seeds. In proportion to their weight the small buttons are as rich in the alkaloidal content as the bigger ones.

These observations are tentative but to confirm them a very much larger number of analyses will have to be made.

(vii) *Myrsine africana.*—During a search for indigenous drugs reputed to be of value as anthelmintics the chemistry of the active constituents of the berries of *M. africana* [vern. *Bebrang* belonging to the family of *Embelia ribes* (N. O. Myrsinaceæ)] was studied. *E. ribes* also is called *Bebrang* in Hindi and in bazaar no distinction is made in the seeds of the two species, the only apparent difference being that the berries of *E. ribes* are bigger (¼") than those of the *M. africana.*

The dried berries on extraction gave a crystalline material of golden yellow colour which has been identified as embelic acid, through preparation and identification of its many derivatives. Along with the

colouring matter is deposited a white crystalline substance, specially when the dye is extracted with rectified spirit. The white crystalline substance is insoluble in most of the organic solvents and crystallises out from hot water in prisms m.p. 328°-30°C. This has been identified as d. quercitol.

(viii) *Indian Artemisia.*—It was reported in 1932-33 that the Kurram *Artemisia* cultivated in Dehra Dun divided itself in two sub-forms, the only distinction between the two being that one produced the flower heads early in June while the other did not show any flower heads till late in the year. It was consequently suggested that the one flowering late was the original form and the earlier flowering one was the acclimitised form. The same observation has now been made in the Kashmir *Artemisia.* The Kashmir *Artemisia* has now properly established itself in cultivation and instead of the two forms stated above there is only one form but it flowers twice a year and consequently has two periods of maximum santonine content, namely June and December. The results tabulated below when put on graph show two parallel curves. *viz.*, one from February to July and the other from August to December,

Time of collection, weeks.	Santonine percentage.	Remarks.
4th August 1933	0·60	Leaves only.
4th October 1933 . . .	0·79	Buds only.
1st December 1933 . . .	0 91	Leaves and buds.
1st January 1934	0·78	Ditto.
1st February 1934 . . .	0·12	Ditto.
1st March 1934	0·66	Fresh leaves.
1st April 1934	0·80	Luxuriant growth but no buds.
1st May 1934	0·84	Ditto.
1st June 1934	0·85	Buds making appearance.
3rd June 1934	0 98	Buds.
1st July 1934	0 52	Early rains dropped the buds.
1st August 1934	0 22	Ditto.
4th August 1934	0·62	Fresh young shoots.

(ix) *Hyoscyamus pusillus* Linn.—Perusal of the literature shows that this species has not been worked for its alkaloidal content. A specimen of this collected in Kargil (Kashmir) showed 0·4 per cent. of an alkaloid. According to the British Pharmacopœia the *Hyoscyamus* leaves should not contain under 0·3 per cent. of the total alkaloids

Hyoscyamus or Henbane is one of those plants which thrives very well in Northern India and the alkaloid content increases on cultivation. It is, therefore, encouraging to find a wild species so rich in the alkaloids.

I. B.—Oils and Fats.

The study of the Lauraceae fats has been in progress for the last few years with a view to finding the possible indigenous source of lauric acid The fat of *Actinodaphne hookeri* as an indigenous source of lauric acid has already been pointed out. In view of the fact that sodium lauryl sulphate is coming into considerable prominence as a base for new detergents, an opportunity is taken to suggest that this and the similarly constituted fats of the *Litsaea* spp. (*N. O. Lauraceae*), over 60 varieties of which are known to be found all over the country, could serve as better raw material for the purpose than the cocoanut and palm kernel oil (trilaurin content under 50 per cent.) employed at present. This is apparent from the high trilaurin content of some of these lauraceae fats, namely *Actinodaphne* 96, *Litsaea sebifera* 96 and *L. lanuginosa* 70 per cent. Recent work on new detergents has shown that the alkali salts of lauryl sulphate possess certain properties which from the point of view as detergents are superior to those possessed by ordinary soaps. For instance, the amount of sodium lauryl sulphate required for washing is practically independent of the hardness of water, whereas the amount of the ordinary soap required to do the same work increases rapidly with the hardness. This is because its calcium and magnesium salts, unlike the calcium and magnesium salts of the fatty acids of high molecular weight are themselves good suspents and good detergents. Furthermore, sodium lauryl sulphate is not easily affected by salt as ordinary soaps are and performs as well in sea water as in tap water.

This work has now been extended to a few more of the *Litsaea* spp. growing locally and *Litsaea lanuginosa*, *L. zeylanica* and *Cinnamomum camphora* have been investigated during the period under review.

(i) *Litsaea zeylanica* Nees.—Syn. *L. umbrosa* Nees. vern. *Shurur* (Jaunsar), is a moderate sized evergreen tree common in Jaunsar and Tehri Garhwal 4—7,000 ft. The berries yield an oil which is used for burning purposes and is considered by the hill people as a specific for itches and other skin diseases. The berries give 36 per cent. of the oil having the following constants—

Colour	brown
Specific gravity at 25°C	0·9363
Refractive index at 25°C	1·4520
Iodine value (Hanus)	38·3
Saponification value	219·1
Acetyl value	12·7
Hehner value	89·0
Acid value	0·6
Unsaponifiable matter	0·9 per cent.

The *Litsaea zeylanica* fat reported last year had been obtained from the berries received from Bangalore. The present fat has been obtained from the Jaunsar *Litsaeas* and appears to be slightly different in its constituents from the Bangalore species Work on the isolation and identification of the constituents is in progress.

(ii) *Litsaea lanuginosa* Nees.—It is a moderate sized tree with brown bark found in Dehra Dun, Jaunsar and Tehri Garhwal. The berries gave 94 per cent. of kernels which yielded 38·5 per cent. of a pale yellow oil under hydraulic pressure and a further 13·5 per cent. on solvent extraction. The oil sets hard on cooling and then has a m.p. 37°-38°C and an iodine value of 30. The fat when ground with alcohol loses most of its colouring matter and the unsaturated constituents, giving a nearly colourless fat of iodine value 6·5 and m.p. 41°-44°C. This indicates a large proportion of trilaurin in the fat.

(iii) *Cinnamomum camphora* Linn.—The camphor seeds were collected locally. The oil had the following constants :—

Consistency	Thin
Colour	Yellow
Specific gravity at 25°C	0 9250
Refractive index at 25°C	1·4442
Saponification value	272·3
Iodine value (Hanus)	4·0
Acetyl value	1·8
Hehner value	91 0
Acid value	1·4
Unsaponifiable matter	0·7 per cent.

The work on the isolation and identification of the constituent acid is in progress.

(iv) *Melia azedarach* Linn.—The Persian Lilac.—In view of the reported medicinal value of the leaves, fruit, etc., of this tree and its similarity to the famous *Neem* tree (*Azadirachta indica*) its oil has been examined. The following are the characteristics of the oil :—

Moisture in the kernels	8·2 per cent.
Oil in the kernels	33 per cent.
Colour	Dark brown.
Consistency	Thin.
Optical rotation	*Nil.*
Specific gravity at 25°C	0·9192
Iodine value (Hanus)	135·8
Saponification value	184·3
Acetyl value	33·8
Hehner value	92·0
Acid value	23·4
Unsaponifiable matter	1·0 per cent.

Chemical constants of the mixed fatty acids of the oil—

Mean molecular weight	320·2
Iodine value (Hanus)	65 5
Saturated acids	5·9 per cent.
Unsaturated acids	94·1 „

The oil appears to be a mixture of the glycerides of palmitic, stearic, oleic and linoleic acids. It is a drying oil.

(v) *Celastrus paniculata* Willd.—The oil from its seeds known as the 'Black oil' is used in Ceylon as a nerve stimulant. It has also been reported to be a 'sovereign remedy in Beri-beri'. In view of the reputed medicinal properties of both the oil and the seeds the chemical examination of the kernel oil was undertaken. The data so far collected is reported below :—

Moisture in the kernel	4·3 per cent.
Oil in the kernels by expression	20 5 „
Total oil in the kernels	50 0 „
Colour	Brown.
Specific gravity at 20°C	0·9701
Refractive index at 20°C	1·4693
Saponification value	265·4
Iodine value (Hanus)	94·4
Acid value	25·3

Chemical constants of the mixed fatty acids of the oil—

Mean molecular weight	282·3
Iodine value (Hanus)	99 4
Saturated acids	30 5 per cent.
Unsaturated acids	69·5 „

I. C.—Other products.

Bombax malabaricum.—It is a tree of great economic value since it yields a variety of useful products. An account of this is recorded in the Dictionary of Economic Products of India by Watt, but since that time more information has accumulated regarding the properties and possible uses of *semul* (*B. malabaricum*) which has enhanced its value. In some quarters, however, exaggerated estimates are being put forward regarding its commercial possibilities. It has, therefore, been thought desirable to bring together all the available information regarding these products so that a more correct estimate about their economic value may be formed. Up-to-date information about the wood; the floss (kapok); the seed oil; the seed cake; the gum (*mocharus*) and the roots has been gathered together and incorporated in a paper published in the Indian Forester. The tap root has also been investigated since

the properties of the *semul* root are described in the indigenous system of medicine in glowing terms. The chemical analysis, however, do not fully support the claims made by the Ayurvedic medicine. The only substance that could impart to the root its medicinal property appears to be the phosphatide which it contains. But it is interesting to note that *semul* like the roots of *Asparagus adscendens* and of *Chlorophytum aurendinaceum*, is also highly mucilaginous. It is possible that the mucilage acts as a demulcent tonic.

2. *Forest Soils.*

Black *kallar* soils from Chichawatni (Punjab) and Sindh, seashore soils from the Cochin Harbour, *Usar* soils from the United Provinces have been examined besides the soils from the experimental plots in the Institute.

3. *Miscellaneous Enquiries.*

(i) *Fluorescence of wood under Ultra Violet light.*—It has been known for a long time that aqueous extracts of certain timbers (*Aesculus hippocastanum*, *Fraxinux excelsior*, *Pterocarpus* spp.,etc.) exhibit fluorescence when viewed in sunlight. This phenomena, however, is not general but is restricted only to the extracts or infusions of the bark or wood of certain species, which by themselves seldom show any fluorescence, when viewed in sunlight, and as such was never considered as a definite criterion amongst the physical properties of timber. Fluorescence, which in a large number of substances both organic and inorganic is weak and indefinite in the sunlight is greatly intensified when viewed in Ultra Violet light; and bodies which exhibit little or no fluorescence when viewed in the sunlight begin to show brilliant and often characteristic fluorescence under this light. It is thus a new aid to analytical work. Hitherto, the application of this method to the study of wood has been very scanty and, therefore, an extended study of this subject has been made on Indian timber, using wood blocks, powder and their extracts in common organic solvents. In some of the species the fluorescence is very striking and it is believed that a systematic study of this phenomena, correlating the nature of fluorescence with constituents of timber and its anatomical structure may prove of value as an aid to identification.

More than a hundred specimen of Indian timbers have been examined and most of these have been found to fluoresce under ultra violet light. Different woods showed different fluorescence, the colour ranging from snuff brown to violet with practically all shades of orange, yellow, green, blue and indigo between these extremes. Intensity of fluorescence, however, is not restricted to any particular part of the wood. In some

cases the heartwood fluoresces more brilliantly than the sapwood, and in others reverse is the case. Then again, in many cases the colour of fluorescence in sapwood and heartwood is altogether different. The colour of fluorescence exhibited by wood blocks and wood powder was more or less identical but, in many cases, the extract shows a different fluorescence.

The colour and nature of fluorescence exhibited by a timber is apparently dependent upon the proportion and distribution of its constituents, such as starch, colouring matter, gums, resins, etc., and it has already been noted by different workers that these constituents show different fluorescence under ultra violet light. For instance, starch gives a blue fluorescence, colouring matter a yellow, resins orange and so on. The study of fluorescence of wood under ultra violet light has thus opened up the possibilities of locating these substances in different parts of the wood. To extend this study efforts were made to locate the constituents which are responsible for fluorescence in *Albizzia lebbek*. Heartwood of this species shows bright orange colour alternate with reddish brown rings and the sapwood light blue. For examination, a section ($3'' \times 1\frac{1}{2}'' \times \frac{1}{4}''$) containing both the heartwood and the sapwood was cut and successively extracted with petroleum ether, sulphuric ether, chloroform, acetone, rectified spirit and finally with water. After each extraction, the piece was dried in vacuum and studied under ultra violet light alongside the comparison block to notice if any change in the colour and depth of the fluorescence had been produced due to the loss of any of its constituents, by the solvent. Petroleum ether, sulphuric ether and chloroform produced no effect, but acetone and alcohol removed the orange colouring matter. That is to say after complete extraction with rectified spirit the orange rings disappeared altogether and the solvent began to show deep orange fluorescence. The blue colour still remained but this was more or less completely removed by extraction with boiling water, thus showing the carbohydrate nature of the deposit.

In trying to differentiate between *Dipterocarpus tuberculatus* and other varieties of *Dipterocarpus* with the help of ultra violet light it was noticed that freshly cut surface of the former showed a distinct blue violet fluorescence whereas the other varieties showed little or no such fluorescence. All the specimen examined, however, were old and dry. Recently a freshly cut green log of *Dipterocarpus tuberculatus*, which had been exuding a large quantity of oleoresin, was examined under ultra violet light. It was observed that the entire surface of the wood showed the characteristic blue-violet fluorescence and the oleoresin also showed the same fluorescence. From this there is ground to believe that the oleoresin is responsible for the characteristic fluorescence of *Dipterocarpus tuberculatus*. Since the other varieties of *Dip-*

terocarpus contain very much less of oleoresin, they show comparatively feeble or no fluorescence.

(ii) *Estimation of arsenic in wood.*—It is well known that the estimation of very small quantity of arsenic is best made by the Berzelius Marsh Method, but it has been noticed that this method is not of general application especially when arsenic is to be determined in presence of copper and oxidising agents. In work on the determination of arsenic (of the order of 0·005 per cent.) in wood treated with arsenic copper salt solutions, this difficulty was felt and it was noticed that in certain cases the results were deflected by as much as 50 per cent. This led to the search for factors that might be responsible for this deflection. The first thing looked for was the possible disturbance due to the presence of the oxidising agents, such as pottassium dichromate which is present in the wood preserving salts or the nitric acid and the oxides of nitrogen which are left over when the wood is digested with this acid for analysis and the complete removal of which is a lengthy and tedious affair. The second factor responsible for the low arsenic result was found in copper sulphate which is present in the mixture. From this it was concluded that Marsh's method cannot be followed to get accurate results in such cases and reference to the chemical literature on the subject indicated that such conclusions were correct. It was, therefore, attempted to determine the best method for the estimation of arsenic when present along with copper salts and oxidising agents. Several well-known methods were tried and the standard sulphide method, with slight modifications to suit our purpose, was decided upon. This method with a little care can give results of an accuracy of 0·5 per cent. error.

Miscellaneous Enquiries.

A large number of analyses of various substances were undertaken on behalf of the officers of the Institute and the forest officers. Particular mention may be made of the following :—

Casein Cements, Glues, Sandal wood oil, Rosha grass oil, drugs and tannin materials.

APPENDIX I.

Publications of 1934-35.

Serial No.	Title of Publication	Author.	Date of issue.
	FOREST RECORDS		
1	Entomological Investigations on the Spike Disease of Sandal (23) Anthicidae	R. F. Heberdey .	June 1934
2	Methods of Testing the Susceptibility of Timbers to Termite Attack.	C. Dover and R. N. Mathur.	August 1934
3	Immatures Stages of Indian Coleoptera (15) (Scolytidae).	J. C. M. Gardner .	August 1934.
4	Entomological Investigations on the Spike Disease of Sandal (24) Pentatomidae.	N. C. Chatterjee .	August 1934
5	Sur Quelques Longicornes Des Indes (Cerambycidae)	K. N. Plavilshchikov	August 1934.
6	New Termites from India.	T. E. Snyder . .	September 1934.
7	New Ichneumonidae from India and China .	R. A. Cushman .	December 1934
8	Results of Experiments on the Kiln drying of Wood with Ozonised Air.	S. N. Kapur . .	March 1935
9	Interim Report on Work under Project VIII — Testing of Indian Timbers for Veneer and Plywood.	W. Nagle . .	December 1934.
10	A Stand Table for Sal overaged High Forest and Coppice	....	(May 1935)
11	Illustrations of Indian Forest Plants, Part III .	R. N. Parker and C. E. Parkinson.	(June 1935.)
12	Immature Stages of Indian Coleoptera (16) (Scarabaeidae).	J. C. M. Gardner .	(September 1935.)
13	Immature Stages of Indian Coleoptera (17) (Eucnemidae)	J. C. M. Gardner .	(Do)
14	On the Biology of Psyllidae	R. N. Mathur. .	(Do)
15	Neue Brenthiden und Lyciden aus Indien . .	R. Kleine . .	(Do.)
16	Neue Attelabiden aus Indien (Curculionidae Col.)	Eduard Voss . .	(October 1935.)
17	Biology of Braconidae (Hymenoptera) .	C. F. C. Beeson and S. N. Chatterjee.	(*In Press*)
18	Preliminary Survey of the Forest Types of India and Burma.	H. G. Champion .	(*In Press*)
19	A Study of the Soils in the Hill areas of Kulu Forest Division, Part I—An Investigation of Soil Profiles under Deodar, Spruce, Blue Pine and Chir.	E. McKenna Taylor, I. D. Mahendru, M. L. Mehta and R. C. Hoon	(*In Press*)
	FOREST BULLETINS		
20	A Record of the Results obtained with Experimental Treated Sleepers laid in the Indian Railways between 1911 and 1916	S. Kameswara Rao . .	October 1934
21	Cold Weather Planting in Northern India . .	H. G. Champion .	September 1934.
22	Yield Tables for Teak Plantations in Java . .	H. G. Champion .	January 1935.
23	Seasonal Progress of Height Growth in Trees .	H. G. Champion .	March 1935
24	Effect of Defoliation on the Increment of Teak Saplings.	H. G. Champion	January 1935
25	Official List of Trade Names of Indian Timbers .	..	(July 1935)
26	Damage by Frost at New Forest, Dehra Dun .	Bachaspati Kashyap	(September 1935.)

APPENDIX I—*contd.*

Serial No.	Title of Publication.	Author.	Date of issue.
	OTHER PUBLICATIONS.		
27	Forest Research in India, 1933-34, Part I.—The Forest Research Institute.	....	October 1934.
28	Forest Research in India, 1933-34, Part II.—The Provincial Reports.	....	March 1935.
29	Classified List of Officers of the Indian and Provincial Forest Services and of the Indian Forest Engineering Service in India and Burma on the 1st July 1934.	....	December 1934.
30	Manual on the Air Seasoning of Indian Timbers .	S. N. Kapur . .	December 1934.

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APPENDIX III.

Statement showing Officers-in-charge of Branches and Sections during the year 1934-35.

Branch	Officer in Charge	Section	Officer in Charge	From	To
Silviculture .	Mr H G Champion, Silviculturist	..		1-4-1934	13-11-1934
				21-2-1935	31-3-1935
		Experimental .	Mr. P. N. Deogun	1-4-1934	17-11-1934
		Statistical .	Mr V. A Kalazal	1 4-1934	31-3-1935
Botany .	Mr. C E Parkinson, Forest Botanist	.	..	1-4-1934	31-3-1935
		Mycology .	Dr K D Bagchee	1-4 1934	8 8-1934
			Dr. K D Bagchee	24-8-1934	31-3 1935
Economic	Capt. H Trotter, Forest Economist	..	..	1-4-1934	7-2-1935
	(Mr W. A. Bailey)	..	..	8 2-1935	31-3-1935
		Minor Forest Products	Capt H. Trotter .	1 4-1934	7-2-1935
			(Mr W. A Bailey)	8 2-1935	31-3-1935
		Timber Testing.	Mr. L N Seaman	1 4 1934	5 3-1935
			(Mr V. D. Limaye)	6-3-1935	31-3-1935
		Wood Preservation	Mr. S. Kamesam .	1-4-1934	23-9-1934
			(Capt H. Trotter)	24 9-1934	21-10-1934
			Mr. S. Kamesam .	22 10-1934	31-3-1935
		Seasoning	Dr S N. Kapur .	1 4-1934	22 12 1934
			(Mr. A. Rehman) .	23 12-1934	6-3-1935
			Dr. S. N. Kapur .	7-3-1935	31-3-1935
		Paper Pulp	Mr. M P. Bhargava	1-4-1934	31-3-1935
		Wood Technology.	Mr. K A. Chowdhury.	1 4 1934	31 3-1935
		Wood Workshop	(Capt. H Trotter)	1-4-1934	2-11-1934
			Mr W. Nagle .	3-11-1934	31-3-1935
Entomology .	Dr. C. F. C Beeson, Forest Entomologist	..	..	1-4 1934	10-7-1934
	(Mr. J. C M Gardner)	..	..	11-7-1934	25-10-1934
	Dr. C F. C Beeson	..	..	26-10-1934	31-3-1935
		Systematic Entomology.	Mr. J. C M Gardner .	1-4-1934	31-7-1935
Bio-chemistry	Dr. S Krishna, Bio-chemist	..	..	1-4-1934	31-3-1935

APPENDIX IV.

Annual Form No. 24.

Forest Research Institute.

Summary of Revenue and Expenditure during 1934-35.

[illegible]	Direction	Silviculture Branch	Botany Branch	Entomology Branch	Economic Branch	Chemistry Branch	TOTAL
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
REVENUE							
I.—Miscellaneous—							
(1) Other receipts	512	339	65	74	3,140	..	4,150
(2) Sale of timber and furniture from Seasoning and Wood Workshop Depot	..	..	..	..	481	..	481
Total Revenue	512	339	65	74	3,621	..	4,031
EXPENDITURE							
A.—Conservancy, Maintenance and Extension—							
A. 1.—Purchase of stores, tools and plant	527	311	975	122	5,835	13	7,783
A. 2.—Communications and buildings Repairs and Maintenance	279	..	..	..	..	..	279
A. 3.—Miscellaneous—							
(1) Temporary Establishment (a) daily labour	4,912	1,562	3,837	2,376	2,697	421	15,804
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges)	..	..	..	..	5,640	..	5,640
(3) Purchase of coal, raw materials, chemicals and apparatus	..	..	..	73	10,524	1,586	12,183
(4) Other charges	92	[illegible]	1,712	735	11,450	235	20,037
Total A.—Conservancy, Maintenance and Extension	5,616	[illegible]	6,884	3,306	37,155	[illegible]	[illegible]

APPENDIX IV—*contd.*

ANNUAL FORM No. 24—*contd.*

FOREST RESEARCH INSTITUTE—*contd.*

Summary of Revenue and Expenditure during 1 34-35—contd.

Budget Heads	Direction	Silviculture Branch	Botany Branch	Entomology Branch	Economic Branch	Chemistry Branch	TOTAL
1	2	3	4	5	6	7	8
	Rs	Rs.	Rs.	Rs	Rs	Rs	Rs
EXPENDITURE—*contd*							
B —Establishments—							
I —Pay of officers—							
Non-voted—							
(b) Superior officers.	13,211	11,436	...	26,496	17,708	...	68,851
Voted—							
Superior officers .	760	12,250	30,610	12,045	1,04,231	22,224	1,82,180
II —Pay of Establishment	33,568	20,952	10,717	24,578	95,937	4,761	1,90,513
III.—Allowances—							
(b) House-rent and other allowances—							
Voted . . .	652	...	...	...	...	...	652
Travelling allowances—							
(d) Superior officers—							
Non-voted . .	180	976	...	1,876	213	...	3,245
Voted . . .							
(e) Subordinate forest and depot establishments	1,935	1,658	2,801	3,526	7,268	221	17,409
(f) Office Establishments							
IV—Contingencies—							
(a) Stationery . .	36	600	42	...	5	...	683
(b) Carriage of records and texts	302	191	631	1,041	42	...	2,207
(c) Rents, rates and taxes	11,519	121	334	2	22	...	11,048
(d) Pay of menials	...	...	...	...	...	...	...
(e) Official postage	640	300	350	1,[illegible]	325	62	2,228
(f) Sundries	11,627	532	625	1,630	1,[illegible]	542	18,918
(g) Clothing and uniform	374	86	37	154	29[illegible]	[illegible]	9[illegible]
(h) Telephone	1,185	294	320	399	1,[illegible]	[illegible]	3,972

APPENDIX IV—*concld.*

ANNUAL FORM NO. 24—*concld.*

FOREST RESEARCH INSTITUTE—*concld.*

Summary of Revenue and Expenditure during 1934-35—concld.

Budget Heads	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch	Economic Branch	Chemistry Branch	TOTAL
1	2	3	4	5	6	7	8
	Rs	Rs.	Rs	Rs	Rs.	Rs.	Rs.
EXPENDITURE—*concld*							
V —Cost of passage granted under Superior Civil Service Rules, 1924 (Non-Voted)	4,288	436	--	1,200	600	--	6,524
Total B —Establishments	79,447	49,632	46,487	73,209	2,30,154	23,423	5,09,414*
GRAND TOTAL OF ALL EXPENDITURE UNDER S.—FORESTS	85,263	54,462	53,071	76,515	2,69,309	30,678	5,71,160*
Major Head S-A —Share of Capital charges financed from ordinary revenue	--	--	--	503	421	--	939
Surplus or deficit	—84,751	—54,103	—53,006	—77,009	—2,66,109	—30,678	—5,67,518*

* Details for the distribution of Rs 1,862 included in these figures on account of publications through High Commissioner are being obtained from the Accountant General, Central Revenues, New Delhi.

NOTE.—The figures given in this statement have been prepared in the President's Office and are based on the Summary of Revenue and Expenditure for March 1935 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through High Commissioner on miscellaneous items

C. G. TREVOR,

President,

Forest Research Institute and College.